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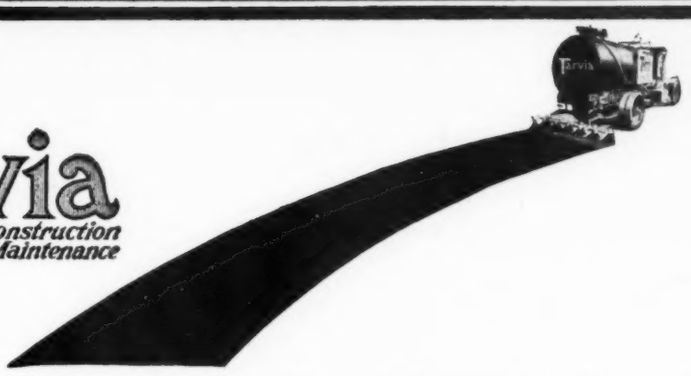

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Illustration No. 1 shows a typical worn out stone road over which it is impossible to drive in comfort at even a most conservative rate of speed. In illustration No. 2 the rear scarifier is loosening the surface from shoulder to shoulder. In No. 3 the blade is being used to level the scarified surface; the leaning front wheels, an exclusive Austin feature, enabling the blade to handle a full load without forcing the front end of the machine into the ditch. Illustration No. 4 shows the smooth surface of the finished road, which is once more ready for high speed traffic.

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PUBLIC WORKS

CITY COUNTY STATE

A Combination of "MUNICIPAL JOURNAL" and "CONTRACTING"

Vol. 57 · August, 1926 No. 7

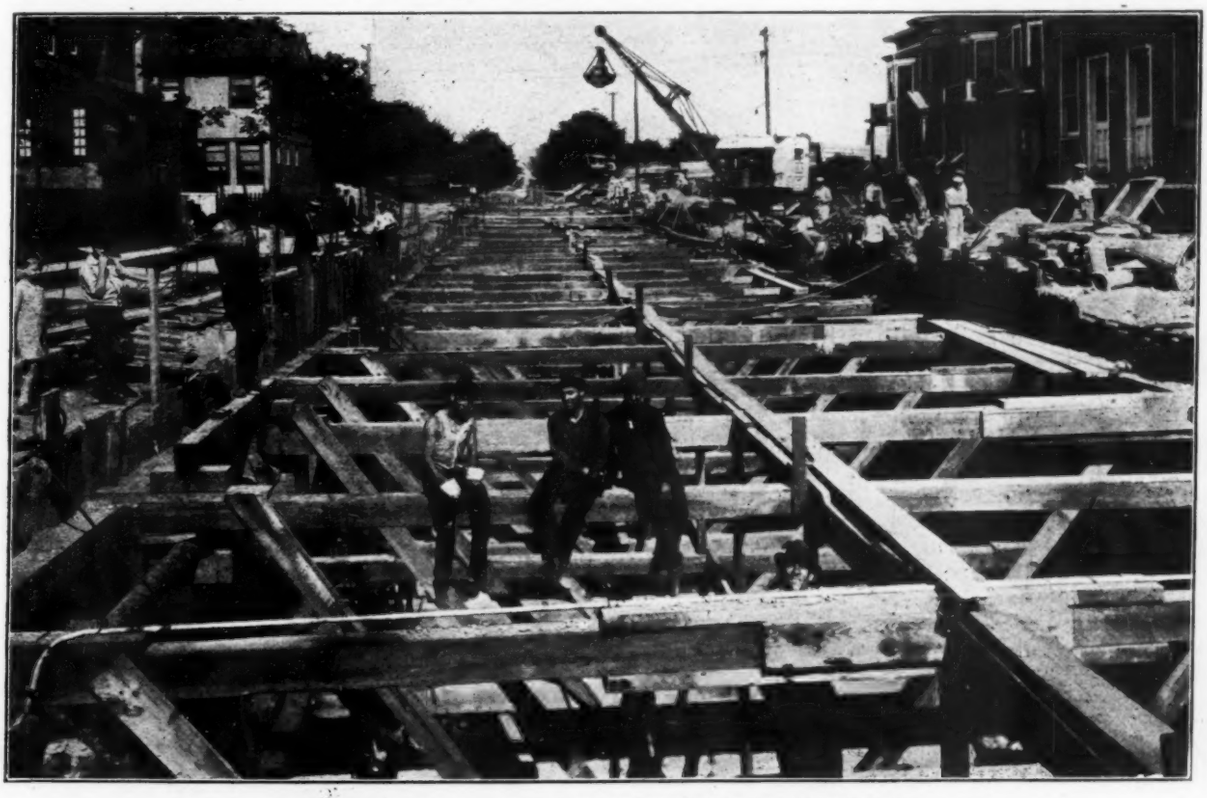
Flatbush, Brooklyn, Relief Sewer

Rapid open trench construction of multiple barrel sewer draining an area of 3,500 acres, with a capacity of nearly nine million cubic feet of water.

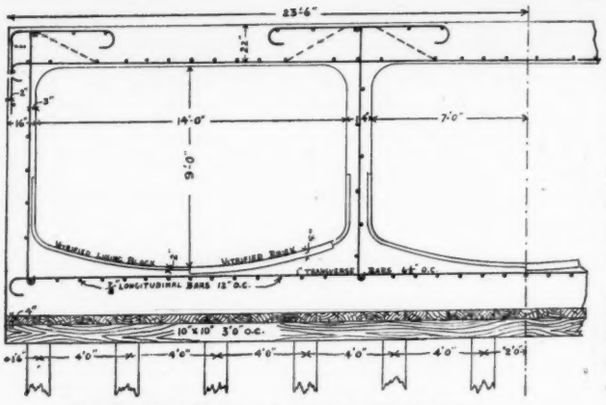
One of the largest sewers in the country, the Flatbush relief sewer, is now approaching completion in the borough of Brooklyn, New York City. Aside from its size, there are some features of construction which make this work unusually interesting.

This is an outfall sewer designed to carry, at its lower end, a maximum flow of 2,460 cubic feet per second of storm water from a comparatively flat, sandy area of about 3,500 acres, most of which is closely built up with good class residences and some manufacturing and commercial buildings, and which has a large mileage of paved and some macadam streets. The storm water system which formerly served part of this district had become inadequate, but part of it will be incorporated with the new system, while other parts will be abandoned or removed.

The new sewer has one 132-inch branch and one 150-inch branch starting from different points on Foster avenue and uniting in a 180-inch section at Farragut road and East 26th street, whence it proceeds with increasing dimensions to its terminus at the receiving chamber at Ralph and Flatlands Avenue, where it is a triple barrel, 216-inch. (The dimensions given

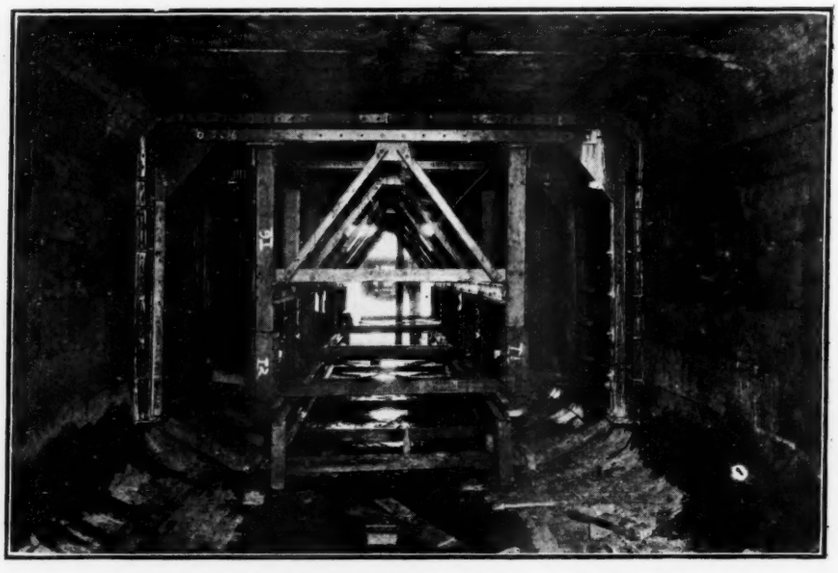


CONSTRUCTING TWO 9x13-FOOT SEWERS IN AVENUE H.



CROSS-SECTION OF HALF OF TRIPLE-BARREL SEWER.

are those of a single circular sewer of the same equivalent area). The total length is 14,800 lineal feet, of which 495 feet is single barrel 132-inch, 1,453 feet is single barrel 138-inch, 1,338 feet is single barrel 150-inch, 4,419 feet is double barrel 180-inch, and 2,625 feet is triple barrel 216-inch.



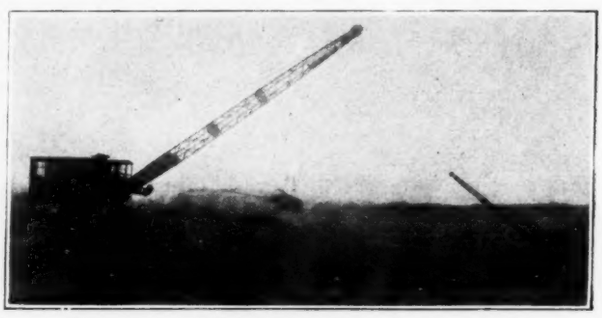
STEEL FORM FOR TRIPLE-BARREL SEWER SECTION.

All these are built with a heavily reinforced concrete invert, vertical walls and a flat roof; the invert being saddle shape and paved with vitrified brick or tile lining blocks. The concrete is mixed 1:2:4, the contractor using six bags of cement per batch. Generally, the invert concrete has been laid directly on the sandy bottom of the trench, although in some cases it is carried on a platform of four-inch longitudinal planks supported by transverse sills three feet apart. In the multiple-barrel sewers the partition walls also are reinforced.

For convenience of organization, equipment and operation, the Montrose Contracting Company, which has the contract for this work, divided it into two sections having entirely separate organizations and equipment. Section A, the estimated cost of which is nearly two million dollars, is under the direct supervision of D. W. Armstrong, general superintendent of all the work. It extends from the receiving chamber at Ralph Avenue, near the outlet, for about 7,000 feet to the beginning of the 180-inch two-barrel construction at East 37th Street. It contains 3,615 feet of 204-inch triple-barrel sewer with 9x14 feet conduits, and 2,523 feet of 198-inch double barrel sewer with 9x16 feet conduits, together with the necessary reducing chambers, manholes and other appurtenancess.

The total quantities involved in this section include 300,000 cubic yards of excavation; 60,000 cubic yards of concrete which requires about 270,000 bags of portland cement; 29,000 yards of sand (excavated from the trench), 58,000 yards of broken stone (from the Tompkins Cove Stone Company) supplied by the B. Turecamo Construction Company, and 3,800 tons of reinforcement steel from Belgium; 1,600,000 vitrified paving brick (from the A. S. Reid Brick Company); 1,500,000 feet B. M. of timber for sheeting, bracing, etc.; and 175,000 feet of 4x12 inch planks for a 25-foot roadway alongside the trench, besides a large amount of dressed lumber for wooden forms.

Section 8 extends from the 198-inch sewer at the end of Section A at Avenue H and East 37th Street, about 7,700 feet through Avenue H, East 27th Street, Farragut Avenue and East 21st Street to Foster Avenue. It consists of 4,419 feet of 180-inch two-barrel sewer, with 9x13 feet conduits; 1,338 feet of 150-inch, 1,453 feet of 138-inch, and 495 feet of 132-inch single-barrel sewer, 9 feet high and of different widths. This construction requires about 39,000 yards of concrete, using 176,000 bags of cement, 35,000 yards of broken stone, 18,000 yards of sand, 600,000 square feet of wooden forms, 5,100,000 pounds of deformed reinforcement steel, and 20,000 square yards of vitrified brick for lining. The excavation totals about 170,000 cubic yards.



EXCAVATING TRENCH WITH TWO LINK BELT CRANES USING DRAG LINES.

The work on Section B is being done under the direction of Louis 'Bee Wilcox, superintendent in charge of all equipment and methods of construction. The total cost of this section will be about $1,300,000, of which work to a value of about one million dollars had been completed by January first of this year, work on this section being now about six months ahead of schedule time.

Section A and Section B differ quite materially not only in size of sewer, but also in the physical conditions encountered. Section B, at the upper end of the sewer, required only about two-thirds as much excavation and materials as Section A and was largely located in paved streets in a well built up residential district where street traffic had to be carefully maintained alongside the sewer, and there was comparatively little trouble from ground water. In Section A, where the trench was deepest and the sewer largest, a considerable portion of the alignment was in unimproved streets where there was no restriction to traffic obstruction; and here there were very large quantities of ground water to be contended with.

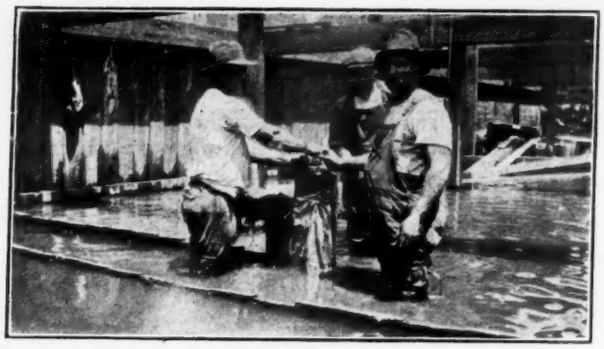
CONSTRUCTION METHODS

Asphalt and concrete street surfaces were cut by two pavement busters operated by air from two portable compressors, all furnished by the Chicago Pneumatic Tool Company. Both excavating and backfilling were performed by three ¾ yard steam shovels, four gasoline engine crawler cranes with 50 foot and 60 foot booms, and three locomotive cranes. With this were used four Dreadnaught and four ¾ yard clamshell excavating buckets, steam shovel dippers, and four ¾ yard drag line buckets. A large fleet of motor trucks, including several five-ton Corbett and five-ton Pierce-Arrow trucks, were employed to serve the steam shovels and other excavating machines, to bring the concrete, stone and cement, etc.

A large amount of surplus sand was sold for building purposes, but the material to be used for back fill was in most cases deposited in spoil banks on one or both sides of the trench, except that where the street was improved, it was stored in adjacent side streets. Where necessary, the surface of the street was protected by a temporary flooring of long transverse planks which gave abundant bearing for the heavy loads from locomotive cranes and paving machines.

The material excavated over most of the line of sewer consisted of about three feet of top soil, below which was a stratum of clean, coarse, sharp sand, which was found suitable for concrete. The trench varied from about 17 feet to 52 feet in width and had a maximum depth of 35 feet, which carried it down to considerably

PLACING ROOF SLAB REINFORCEMENT ON TRIPLE-BARREL SEWER, AVENUE I.
Shows pipes used as posts to support braces, to be built into partition walls.



AIR-DRIVEN STEAM HAMMER OPERATED PARTLY UNDER WATER.

below ground water level. The vertical sides of the trench were protected throughout with one or two tiers of 2-inch wooden sheet piles driven by double-acting steam hammers, operated by compressed air. Where there were two tiers, the upper one was driven eight inches outside of the lower, and the latter was so located as to act as outside forms for the side walls. The lowest rangers and braces were placed just above the invert and removed as soon as the invert had been constructed and was able to receive the pressure from the bottom of the sheet piles. In general, the braces were set about 10 feet apart; for the narrower trench 8x8 braces were used at the top, 10x10 half way down, and 12x12 for the bottom of the deepest trenches. On Section A, where the sheet piles had a maximum length of 28 feet, the contractor used ten Union Iron Company's No. 6 and No. 8 steam hammers which consume 75 and 50 cubic feet per minute, respectively, of air at 100 pounds pressure. The heavier ones were handled by the crawler cranes and the lighter ones by hand tripods. In open country the trench was carried as deep as was possible to go without sheeting by use of steam shovels loading trucks, which traveled out on plank roadways at the inclined end of the trench. When bracing became necessary, the trench was sheeted and from then on, cranes with clamshells were used for removing the excavation.

In handling ground water, two or three different methods were tried, but apparently the most satisfactory was as follows: the trench was dug about two feet wider on each side than the outside dimensions of the sewer, and short lengths of sheeting were driven along the line of the outside of the sewer, leaving a 2-foot channel between this and the outside sheeting. This channel was carried deeper than the main trench and about a foot depth of broken stone was placed in the bottom to prevent scour. The concrete invert was built in sections about 30 feet long and at the upper end of each section a similar transverse channel was constructed to carry the water from above to the side channels and prevent scour of the invert concrete. The water carried by these side channels was led to a sump which was surrounded by deeply driven sheet piling and, near the outfall, was equipped with two 8-inch electrically driven centrifugal pumps. Further up the line, where the ground water became less, the trench was drained to individual sumps at every concreting section, and thence pumped to adjacent sewer manholes.

In Section B there was little ground water to be handled, and the small amount of storm water intercepted was delivered to adjacent sewers by two portable gasoline pumps, with 4-inch suctions and 3-inch discharges.

CONCRETING

The 1½-inch concrete stone was shipped in barges and placed in storage piles at a general yard, whence it was delivered to a point at or near the sewer by five-ton trucks, 20 of these handling as much as 1000 yards a day. From these street storage piles, the aggregate was loaded by seven wagon-loaders to a fleet of 1-yard dump trucks, which trucks dumped directly into the power elevated charging hoppers of the concrete mixers. Near each concrete mixer one day's supply of portland cement in bags was stored on slightly elevated steel platforms, from which the bags were delivered to the mixers by small wheelbarrow gangs.

The concrete was mixed in paving machines mounted on caterpillar tractions which moved back and forth along the sides of the trench as the invert, side walls and roof slab sections were concreted. They delivered through short chutes directly to the required positions in the forms, except when occasionally conditions required that the concrete be transported in small quantities by trucks. The concrete was mixed by two Oshkosh, one Ransome, one F. L. Smith

SHOWS MANHOLE AND HOUSE CONNECTIONS ON TOP OF FINISHED SEWER.

and one Koehring concrete paver, these five keeping the concrete work well up on the heels of the excavating and timbering gangs.

The reinforcement was in the shape of deformed bars received in 40-foot lengths and cut to length and bent to shape by the contractor, who was provided with burning and welding torches and a hydraulic bending equipment of his own devising. The long reinforcement bars were delivered to the trench by special two-wheel home-made trailers hauled by some of the several tractors, one of which was generally installed in one of the contractor's two repair shops, where it drove the machine tools.

On one section, the invert, side walls, and roof slabs were poured in three successive operations; while on the other section the invert was poured in one operation and the remaining concrete in a second. About 120 lineal feet of Blaw-Knox steel collapsible forms were provided for the 3-barrel section of the sewer, and the remainder of the work was concreted in wooden forms built by the contractor. Of the latter, there were two types, one with side wall forms which were handled separately, the other having both side wall and roof forms mounted on a carriage operated on a broad gauge invert track. Wooden roof forms were adjusted vertically by jack screws and the side wall forms were adjusted both by wedging and by turnbuckle bracing rods. The roof forms were supported during construction by steel pipes used as posts and built into the wall when this was poured; the pipes being filled with concrete and cut off flush with the top of the sewer at the end of the work.

CURVE NEAR OUTLET OF 204-INCH TRIPLE-BARREL SEWER. MANHOLE AT EXTREME RIGHT.

A 40-ft. section of 80-inch sewer, requiring about 30 yards of concrete, was placed by four men in four hours. After 24 hours, the inner surface was paved with brick. An 80-ft. section of side walls was concreted in about four hours by five men. Arch forms were required to stand three days, but the other only 24 hours.

About a month after a stretch of sewer had been completed, the trench was backfilled with earth and sand from the spoil banks, which was handled by the excavating buckets operated by the cranes. The surface of the backfill was dressed with a road finishing machine.

The trucks, locomotive cranes and other equipment had consumed approximately 70,000 gallons of gasoline and 3,500 gallons of lubricating oil at the end of seven months of operation, during which about 85 percent of the contract had been completed. The oil was distributed along the line by a service wagon carrying it in 10 gallon cans.

The contractor maintained at each of the two sections a repair shop and storage yard equipped with hand and power driven machine tools, where all minor and ordinary repairs to the plant were executed and where wooden forms and small equipment were built.

The sewer was built under the direction of A. J. Griffin, chief engineer of the Bureau of Sewers of Brooklyn Borough, James J. Browne, superintendent, and Philip P. Farley, consulting engineer.

Sewage Aeration and Water Hardness*

It has been previously shown by the author and his colleagues that the decomposition of sewage occurs very slowly when mixed with sea water or other saline solutions. In the present investigation experiments were carried out to determine if the hardness of the water employed for carrying the sewage had an influence on the rate of decomposition. Mixtures of domestic sewage and soft water (distilled) and of domestic sewage and hard water (18.5° and 25°) were aerated under parallel conditions at varying rates and for different periods of time. The results of these experiments showed that oxidation occurred much more rapidly in the soft water mixtures than in the hard water mixtures, the free and albuminoid ammonia and oxygen consumed values in every instance being lower in the former than in the latter after aeration. The nitrites were irregular but the nitrates were invariably higher with the soft water. It was also observed that the hard water mixtures were more opalescent in appearance, probably due to the precipitation of colloidal substances. This would increase the amount of sludge deposited during tank treatment, thus reducing the load on the subsequent treatment processes employed. The imporance of considering these factors in comparing the results of different plants and methods of purification is emphasized.

Decatur's Water Works Financing Legal

We described in our issue of May 13, 1922, the method employed by the city of Decatur in raising money for constructing the reservoir known as Lake Decatur, when it was found that the city could not issue bonds for the amount necessary without exceeding its legal bonding power. In this emergency, a company was organized known as the Decatur Water Supply Company, the stock of which was taken by citizens, this company to raise the money for building the reservoir and to receive 90% of the net receipts of the municipal water works until interest and principal had been paid off.

*Abstract, by Bureau of Public Health Service, of paper in the "Surveyor" (England) by J. E. Purvis, chairman Cambridge Sewage Disposal Committee.

A tax payer's suit was brought against the city and the water company to have the courts declare this arrangement illegal on the ground that it was a subterfuge to evade the constitutional bond limit of the city. On June 16th the State Supreme Court, affirming a verdict of the Macon County Circuit Court, upheld the legality of this contract.

Electrolysis of Water Mains

A sub-committee of the American Committee on Electrolysis is making a study of the National Electrical Code rules on grounding of electrical circuits on water pipes so far as this practice may affect the electrolysis conditions of the water pipe system. This committee has asked the New England Water Works Association and the American Water Works Association to obtain from their members information in regard to the general experience of water works with electric ground wires and the prevalence of insulating or high resistance joints in water systems.

A questionnaire has accordingly been sent to the members of these associations asking that each superintendent report the materials composing existing mains and services, with the miles of each; the types of joints used in mains and services and to what extent insulating joints are used. If such joints are used in services, where they are located with reference to the buildings supplied; also where meters are located, whether in the building or at the curb. Replies to these questions are desired concerning both existing mains and those which are being or about to be installed. The superintendents are then asked to give a detailed account of any troubles that they may have experienced within the past ten years due to the practice of grounding electrical circuits on water pipes, and whether these were alternating current or direct current.

Rapid Bridge Construction

A bridge spanning Rubio Wash on Valley boulevard, one of the main arteries leading into Los Angeles, Cal., from the east was washed out by a flood last spring, and, because of the amount of traffic that was greatly inconvenienced thereby, it was necessary to replace it as promptly as possible. A contract was immediately let to Oliver G. Bowen, contracting engineer, by the county for a reinforced concrete slab type bridge. This involved four thousand cubic yards of excavation and two thousand of concrete.

Mr. Bowen completed the work in thirty 8-hour working days. The aggregate was dumped by trucks directly into the skip of the mixer—a Rex 21-E paving mixer—and the concrete discharged directly into the forms through chutes that were suspended from the boom of the paver.

POURING CONCRETE FOR BRIDGE ACROSS RUBIO WASH, JUNE 11

San Francisco's Garbage Disposal

The Health Committee of the Board of Supervisors of San Francisco received on June 14th for consideration several proposals for handling the garbage of the city. One contractor offered to carry the garbage thirty miles to sea at a rate of 80c per ton for a five-year contract. The Decarie Incinerator Company offered to build an incinerator with a capacity of 800 tons per day for $1,300,000. The Scavengers' Protective Union, a co-operative organization of local scavengers which now operates the municipally-owned incinerator, offered to build a new incinerator on the site of the old one if awarded a twenty-five year contract. The Ludwig Garbage Incinerator Company offered to build incinerators and operate them on a twenty-five year contract. Previous to this date, the health committee had received a proposal to dump the garbage along the shore of San Francisco Bay at a point where it would be covered with earth and rock which is being placed there under a contract for making a fill at this point.

North Dakota Highways

The North Dakota State Highway Commission has announced that it has reached the limit of the funds at its disposal for 1926 and no more contracts can be awarded this year; in fact, a considerable portion of the work included in existing contracts will need to be carried over into 1927 unless the contractors are willing to wait until next year for their money. There is still available sufficient federal aid for present and additional work but the shortage is in the state aid funds. The only possibility of completing the work projected for 1926 is apparently the adoption and immediate operation of the two cent gas tax measure.

The department has this year awarded contracts for grading and drainage structures on 644 miles of road at a total contract price of $2,224,592, an average cost of $3,454 per mile. The

gravel surfacing contracts cover 208 miles at a total contract cost of $336,409. This makes a total of $2,561,001, of which 25 percent must come from state aid.

In this connection it may be noted that the auto taxes for North Dakota are almost the lowest of those of any of the states, the average motor license per car being $7.47, while the average of all states is $13.06, Oregon leading with an average fee of $24.79. The lowest is California with an average of $5.42 motor license; but an addition personal property tax on automobiles is collected, which is not the case in North Dakota.

Concrete Paving Costs in Tennessee

Unit low bid costs of concrete pavement in Tennessee state road work during the past year.

By O. H. Hampsch*

An analysis of the unit low bid prices for cement concrete pavements awarded since July 1925 in Tennessee State road work shows a cost per square yard varying from $2.15 to $2.49. The standard design used is an 8"—6"—8" slab with a center longitudinal construction joint. In March 1926 the specifications were changed to include a ¾" transverse expansion joint, either poured or premoulded, at 35 foot intervals, the cost of the joints included in the unit price per square yard for cement concrete pavement. Under these new specifications a unit price for shoulders (per mile) was also added, all previous contracts for shouldering having been included in the unit price per square yard for the paving. The state uses ordinarily an 18-foot width of paving, except the trunk roads nearer the larger cities where 20-foot to 24-foot widths are used. The mix is composed of one part portland cement and five and one-half of fine and coarse aggregate, making the aggregate proportioned approximately two parts sand to three and one-half parts stone (or gravel).

Contracts for paving are ordinarily awarded separately after the grading work has been completed and fills compacted. The state awarded approximately 140 miles of concrete paving during the past twelve months.

In considering the awards of the contracts the time limit expressed in working days is computed against the low bid on the basis of the following:

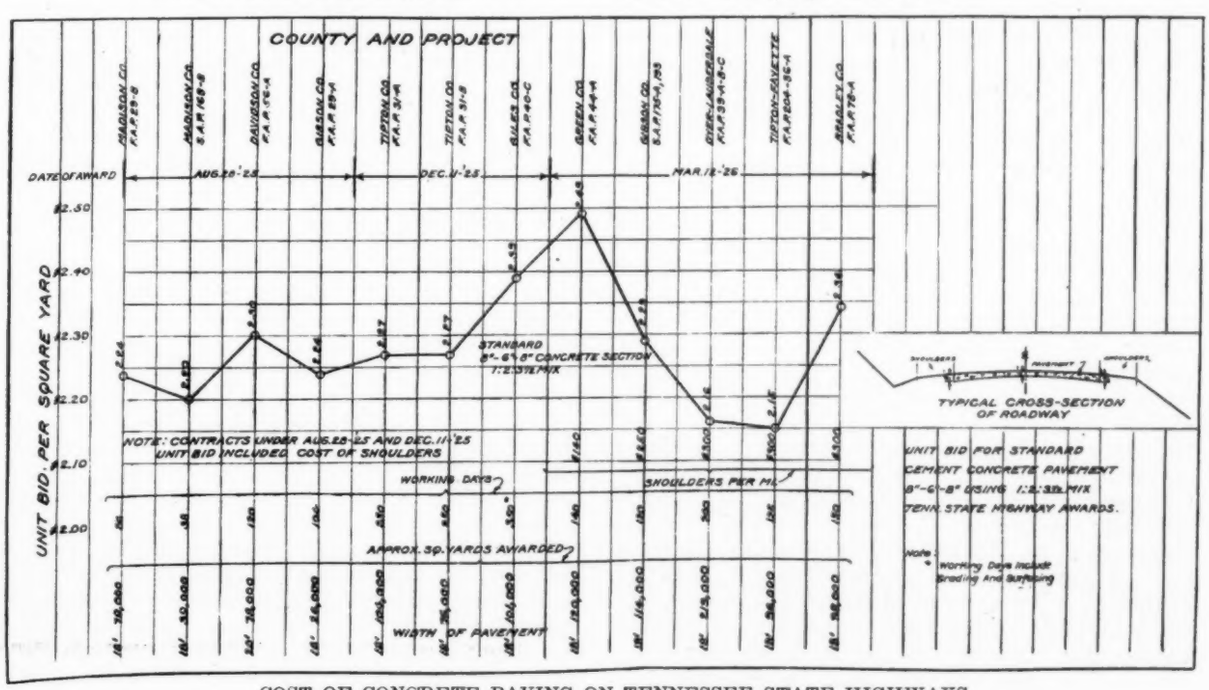
Amount of Original Proposal	Amount of Liquidated Damages Per Day
$10,000 (or less)	$10.00
10,000— 20,000	20.00
20,000— 50,000	30.00
50,000—100,000	40.00
100,000—200,000	50.00
200,000—400,000	65.00
400,000 (or more)	80.00

A working day is considered as any day, except Sundays and legal holidays, when the condition of the weather and soil is such that it is possible for a period of six hours or more to proceed with the project.

*Chief Draftsman, Plans Division, Tennessee Department of Highways and Public Works.

Automatic Slow-Down for Sewage Pumps

The three large centrifugal pumping units in the new sewage disposal plant in Brooklyn are arranged for automatic slow-down to prevent water hammer. This arrangement was designed by the General Electric Company as follows:



COST OF CONCRETE PAVING ON TENNESSEE STATE HIGHWAYS

The pump motors are automatically started by a float switch and, when this closes, an oil circuit breaker is closed, thus throwing voltage on the primary of the motor. The motor then accelerates automatically until it reaches full speed.

When the pump motor is to be stopped the float switch opens and a contactor drops out, thus inserting resistance in the motor secondary and thereby slowing it down. At the same time, a definite time relay is energized, tripping after a predetermined time, thus opening the oil circuit breaker and shutting down the motor.

The three pumps are driven by 125-horsepower, 4150-volt, slip ring G.-E. motors. The Brooklyn plan is one of the first installations in the country where such provision is made.

Pavement and Soil Surveys

Pavement condition and subgrade soils being studied by Michigan Highway Department. Research of soils of Ohio conducted by State Highway Department, State University and U. S. Bureau of Public Roads. Similar cooperative studies in Georgia and Virginia.

By Michigan State Highway Department

A combined pavement-condition and soil survey was begun by the Michigan State Highway Department late in the fall of 1925 but was discontinued because of extremely wet weather and subsequent freezing after 108 miles of pavement-condition and 16 miles of general soil surveys had been finished. Whether the remaining 2,000 miles of the State highways will be surveyed this year depends upon the funds available. In planning the procedure of such survey material assistance was obtained by a study of the methods of the Pennsylvania State Highway Department pavement-condition survey.

The work done last year was described in "Public Roads" by V. R. Burton, engineer on special assignments with the Michigan State Highway Department, as follows:

"Lack of knowledge of the kinds and properties of subgrade soils is the most serious obstacle to a better understanding of the differences in the behavior of pavements laid under apparently identical conditions. It has been felt that this factor must be taken into consideration to make the pavement-condition survey of any great value. It seems to be generally believed that most sandy soils provide a good subgrade while clay soils as a rule are poor subgrade material. The intermediate type, however, with which we are more often concerned seems to be little understood or worse still, not even recognized.

"The decision has been made, therefore, to carry on a soil survey concurrently with the pavement survey for the purpose of determining the proper subgrade and pavement design suitable for a particular soil type under given climatic and traffic conditions. A discussion of this phase of the matter with the official in charge of the land economic survey being carried on in Michigan brought out the fact that about one-third of the State had been covered by some sort of soil survey by that agency and the State agricultural college, both in cooperation with the Bureau of Soils of the United States Department of Agriculture. The older soil maps are, for our purpose, of limited value only since the science of soil mapping and testing has been undergoing almost as rapid a change as that of highway engineering. In addition, the condition and properties of a subgrade soil must be determined in greater detail and from a different viewpoint than even the most recent agricultural soil maps will permit.

"By adopting the Bureau of Soils classification of series and types and profiles it seems possible to diminish to a considerable extent the amount of laboratory testing. For instance the Fox sand is distributed quite generally over this State and differs only slightly throughout the whole area. The recognition of the fact that a given soil type in any particular climate and under similar conditions of drainage is bound to be much the same regardless of the location where it is found is a new idea to the highway engineer and not a very old one to the agricultural soil expert.

"About 100 different types of soil have been identified and mapped in Michigan up to the present time. While this may seem a large number it should be borne in mind that once a type is recognized and tested, very little future testing will be necessary. If every different soil encountered on a highway had to be tested in the laboratory the expense and labor involved would be prohibitive. The value of the Bureau of Soils maps is that they indicate the location of the various types, so that when the subgrade characteristics of all types have been determined the simple identification of the type will, in most instances, be sufficient to stamp the subgrade as good or bad.

"The pavement condition survey party consists of one engineer familiar with construction and three assistants. Two of these assistants chain the pavement, marking it at every 20 feet and painting the station number every 100 feet. The third assistant accompanies the engineer following the chaining party. The engineer and this assistant walk along opposite sides of the pavement locating the cracks and sketching them on specially prepared cross-section paper. All surface defects, such as pitting, scaling, spalling, hair checks, etc., are noted on the sketch. About 4 miles of pavement is an average day's work for this party.

"A soil surveyor skilled in soil mapping follows the pavement party and uses the painted stations to locate the boundaries of the various soil types. A strip of soil 200 feet wide is mapped. After the mapping is completed the soil surveyor returns over the same route and selects typical soil samples which

are sent to the laboratory for routine tests. A sufficient number of samples are tested to determine the extreme upper and lower limits of variation within the type.

"Both the pavement condition and the soil surveys are forwarded to the main office immediately upon completion of the field work and the information is transferred to the original plan which is on a scale of 100 feet to the inch. This sketch is easily readable when the work is done by a neat draftsman and the complete results may then be easily studied or compared. The type of soil, and depth of the roadway in the soil profile, the grades, cross section, surface and subdrainage are all noted and may be read at a glance. Surface data sheets of the pavement survey are prepared in such a way that separate sections of road may be compared slab by slab. The surface data sheets give the slab lengths, number and kind of cracks, the pavement classification based upon the length of the unbroken slab and the area of the pieces of broken slab, the amount of scaling, spalling, and hair checking, etc.

"A study of one phase of the soil survey—the subsidence of fills in peat marshes—has been practically completed. The fills were cross-sectioned by borings so as to determine the actual shape of the floating fill. The classification of the peat strata was made in accordance with the system developed largely by Dr. Alfred P. Dachnowski, of the Bureau of Plant Industry of the United States Department of Agriculture. Testing of peats in accordance with the standard soil methods is impossible since oxidation takes place unless the sample is kept continually moist with the result that a totally different class of material remains. No screen analysis is practicable and shrinkage tests and bearing values must be obtained from the moist material without initial compression."

Soil Research in Ohio

By F. H. Eno*

The soil research being conducted in Ohio is a cooperative project between the Ohio State University, the Ohio State Highway Department and the U. S. Bureau of Public Roads.

The laboratory work has now been under way for about one and one-half years. We have secured a back-ground or foundation of experience and knowledge of soils that furnishes a very good basis for their identification. More than 250 soils have been variously analyzed in the laboratory. We have followed largely the path blazed by the U. S. Bureau of Public Roads in their soil laboratory. I think, however, we originated the percolation test which we are still seeking to develop into a more uniform expression of that soil characteristic.

One fact we have striven to keep in mind is, that road engineers will have little to do with any new-fangled ideas that do not appeal to them as to the practical application, and especially are contractors obtuse to any theory that may be advanced which cannot be practically worked in the field.

We believe that the percolation test can be made very simple, can be correlated with the mechanical analysis of the soil, and will mean to both contractor and engineer direct knowledge as to whether in a given soil, tile drainage can or cannot be used to advantage. It may also call to their attention that in order to rid the subgrade beneath the pavement of the evaporated and then condensed capillary water, it will be necessary to install a porous and well-drained sub-base of slag, gravel or broken stone.

The old slaking test is now being tried with a view to standardization. It is believed that being a simple test it will appeal to road engineers as a quick and definite test to show them a particular need on road maintenance, namely, that upon certain sections of soils, soil indicated by this test, the shoulder next the edge of hard pavements should be constructed of gravel, slag or broken stone and surface treated with bituminous material in order to prevent overrunning traffic from cutting ruts, thus making possible the quick slaking down of the soil beneath the edge of the pavement and the consequent destruction of the pavement.

Various treatments of the sub-base with the idea of stabilizing the sub-base soil are now being tried out in the field beneath Federal Aid roads. Thus far we have tried 2, 4 and 6 inch layers of porous materials, such as sand, gravel, slag and broken stone, also admixtures with the top 2, 4 and 6 inch layers of sub-base soil of hydrated lime and cement in various percentages by volume of the soil layer.

I believe our work last fall has proven conclusively that admixtures are not practicable. They are only of value in dense clay soils, and such soils, when wet, will not break up to permit mixing. The delays incident to rainy weather would more than offset any advantages gained.

Hydrated lime mixed with clay soil makes some very marked changes in the soil characteristics, as shown by our laboratory tests, but we cannot recommend it for practical purposes upon hard surface construction. We are trying to develop a plastic or bearing power test upon soils in the laboratory in order to find out at what point in their moisture content they become unstable for road sub-grades. The experiments have not been carried far enough yet to give a standard method

For nearly the whole year and a half observations have been made at some 60 or more stations in the field, scattered over the north and south limits of Ohio, to determine the varying moisture content of the soils throughout the year. Samples were taken at the surface and at 6, 12, 18 and 24 inches in depth and the moisture content determined. This series of tests, begun in conjunction with the plastic tests, should give us some very valuable information.

Levels have been taken upon some 30 different pavements from different soils to find out how much displacement takes place due to swelling and contraction of soil, freezing and thawing and expansion and contraction of paving material itself. Of course, all this may enter into our observations and it will be difficult to separate out the effect of any individual agent, but the total effect can be determined. In taking mois-

*Professor of Municipal Engineering, Ohio State University.

ture samples, we have kept a record of the depth of frost at each station.

The routine tests of capillarity, moisture equivalent, moisture holding capacity, volumetric change, etc., have been carried on upon practically all the soils brought into the laboratory.

Bureau of Public Roads Making Sub-Grade Field Studies

Field studies of subgrade soils by the U. S. Bureau of Public Roads with State co-operation are in progress in Georgia and Virginia. An attempt is being made to correlate the condition of the pavements on various subgrade soils with the kind and condition of the soil. The ultimate objective, of course, will be to determine the characteristics of good, bad or doubtful subgrade soils, so that they may be readily identified in the future. This should be helpful in selecting adequate pavement designs.

In Georgia eleven Federal-aid projects from 2 to 4 years old, and totaling 75 miles, have been selected for study. The projects were built on various soil types and include topsoil, bituminous, and concrete surfacing.

In Virginia the work is confined to one project located between Fairfax Courthouse and Warrenton. It includes both plain concrete and vibrolithic concrete construction.

The field work in the Georgia investigation is expected to include the mapping of the pavement and ground surface conditions in detail, observations of drainage and topography, and the selection of soil samples for laboratory analysis.

In the Virginia study a survey of the subgrade was made before construction began. While the pavement is being built at the present time, detailed information is being secured on weather conditions, final preparations of the subgrade, character and condition of the materials, method of mixing, and the consistency, finishing and curing of the pavement. A condition survey of the pavement is being made prior to the placement of the wet earth covering. This condition survey will be supplemented later at intervals, beginning when the road is opened to traffic.

East Chicago Sewage Pumping Station

Design of new Alder Street sewage pumping station at East Chicago, Ind., and methods of overcoming construction difficulties. Vertical and horizontal pumps with a total capacity of 145 M. G. D., operated by electric motors with oil engines as a stand-by.

By H. D. White*

The city of East Chicago, Indiana, has a population of about 45,000. It is essentially a manufacturing city, being a part of the great Calumet iron and steel district. The city is divided into two drainage districts, the sewage from which is handled by two pumping stations, one at Magoun avenue and one at Alder street, both discharging into the Grand Calumet river. The sewage is not treated in any way, and after from one to three miles' travel in the river discharges into Lake Michigan. At the present time the Magoun avenue station handles a normal dry-weather flow of 3 M. G. D. and the Alder street station has a dry-weather flow of 6 M. G. D.

The old station at Alder street had been built in 1907 with the bottom of the pump pit foundation at elevation of -20, while the brick influent sewer came in beside the station with the invert at elevation -16.0. Separate conduits for each of two pumps led from the sewer up to the pump pit with a stub left for a future conduit to another pump, which conduit was built in 1914. In building this new conduit, it was necessary to excavate under the pumping station in a sand heavily saturated with water. Evidently there was some leak left in the last connection, allowing ground water and sand to leak into the pump suction line, resulting in the pump literally pumping sand out from underneath the pumping station. This condition showed up in some settlement and numerous cracks in the building which became so bad that the building had to be shored up and the pump discharge pipes freed from the walls to prevent their breaking. It became a necessity in 1925 to build a new station before the old one fell down.

The new plant was placed directly north of the old one. At the start of the design work it was decided to make the new station as automatic and fool-proof as possible, knowing that the station might not always be manned by skilled operators. Therefore, the design was settled on electrically driven vertical pumps for ordinary flows, located in a dry well with motors on the main operating floor, and horizontal pumps on the operating floor for large storm water flows. The vertical pumps are set low enough to require no priming and are automatically controlled by means of float switches. Two of these vertical pumps are 15-inch and of 10 m. g. d. capacity each, and the third one is 30-inch and has a capacity of 25 m. g. d.; the three being amply sufficient to handle the normal flow or a fairly good storm flow. For large storm flows, there are also two 36-inch 50 m.g.d. each, horizontal pumps. The latter pumps are primed by means of two No. 2 Nash "Hytor"

*Of Pearse, Greeley & Hansen, hydraulic and sanitary engineers, Chicago.

wet vacuum pumps, connected through clutches to a 20 h. p. motor. The motor is large enough to run both vacuum pumps together and the vacuum piping to the large pumps is arranged so that either or both vacuum pumps can exhaust the air from either large pump singly or both together. The ordinary time for priming one 36-inch pump with one vacuum pump is 1½ minutes with a suction lift of 10 feet. The average total head for the vertical pump is 20 feet and for the horizontal pump is 16 feet.

The three vertical pumps have both discharge and suction valves while the horizontal pumps are equipped only with discharge valves. All of these valves are equipped with Payne-Deane electric operation and control. The discharge valve circuits on the vertical pumps are interconnected with the main pump motor float circuits so that when a pump automatically starts or stops the valve automatically opens or closes. These pumps and valves can also be manually controlled if desired. All other pumps and valves are controlled manually at the switchboard which is located on a balcony above the pump room floor.

All five pumps were made by the American Well Works and have a recently developed high efficiency open impeller which has much less tendency to clog than the closed type. A revolving bar screen with 2⅝-inch spacing was made and installed by the Link-Belt Company. Thus far this screen has been very effective in removing rags, sticks and other material, although some rags and smaller material get through.

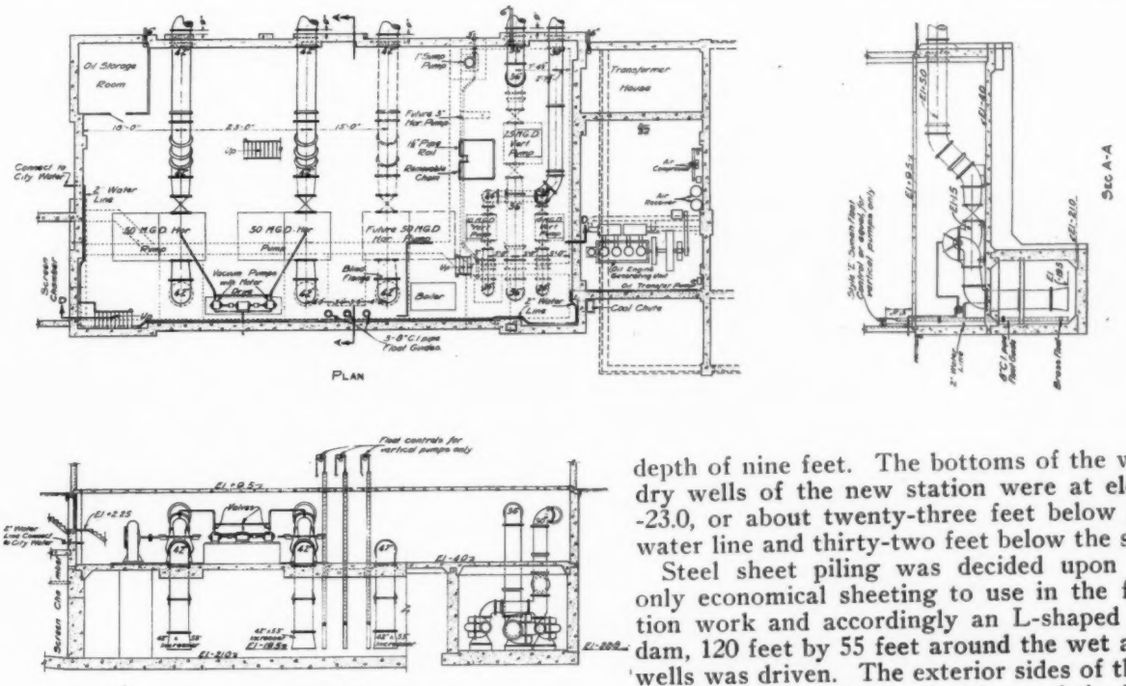
The five main pumps and motors are lubricated by a Bowser automatic circulating, lubricating and filtering system. All of the smaller motor driven auxiliaries are controlled by a switch on the main switch board and also by a switch located close to each unit.

Power is supplied by two separate 11,000 volt lines from the Northern Indiana Gas and Electric Company. These are stepped down to 2,300 and 220 volts. As there is a possibility of these lines being out of service at times, generally during a storm when the heaviest flows are coming in, it was decided that some standby power was necessary. This standby power is furnished by a 300 h. p. Venn-Severin low pressure oil engine, direct connected to a generator which supplies power through a standby switchboard to the main bus on the large switchboard. This gives a very flexible standby unit, as the power generated can be used to run any of the pumps or auxiliaries, or for lighting. The engine is large enough to operate the three vertical pumps together or one 36-inch pump alone; or, in other words, will operate a capacity of 50 m. g. d.

CONSTRUCTION DETAILS

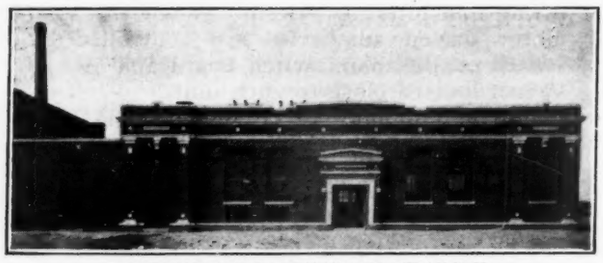
Those who are familiar with soil conditions throughout the Calumet district at the south end of Lake Michigan in Indiana know that this territory is underlain with blue clay, covered to a depth of from five to thirty-five feet with fine sand. The topography at East Chicago and Indiana Harbor is practically flat and the ground level is only a few feet above lake level. The pumping station site is located about one and three-quarter miles from the lake shore and about one-half mile from the Grand Calumet river, which connects with the lake. Clay was struck here at a depth of thirty-five feet or at about elevation -26.0, and ground water at a depth of nine feet. The bottoms of the wet and dry wells of the new station were at elevation -23.0, or about twenty-three feet below ground water line and thirty-two feet below the surface.

Steel sheet piling was decided upon as the only economical sheeting to use in the foundation work and accordingly an L-shaped cofferdam, 120 feet by 55 feet around the wet and dry wells was driven. The exterior sides of this cofferdam were of 29 foot sheeting and the interior sides or those walls which came below the main



PLAN

PUMP LAYOUT AT ALDER STREET STATION, EAST CHICAGO



EAST CHICAGO PUMPING STATION

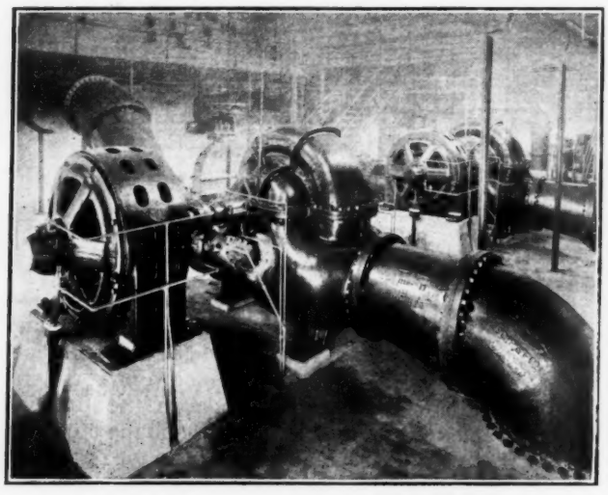
pump room floor were of 25 foot lengths. All of the steel was 16 lb. Carnegie. Considerable difficulty was experienced in driving the 29 foot lengths as the sand was extremely fine and hard packed and the sheeting was a little too long for such a light weight section. It appears that about 25 feet is about the longest length sheeting of this section that can be driven conveniently, as the tendency for longer lengths is to bend in the ground while being driven, even with a water jet, causing the next piece of sheeting to bind in the groove. A 50-pound pressure 2-inch water jet was used in jetting the piles. At first the contractor attempted to use a 2,400-pound drop hammer, but soon gave this up in favor of a McKiernan-Terry steam hammer which did much better and faster work. The steam hammer also did not batter and bend the ends of the sheeting as the drop hammer did.

Excavation was carried down to thirteen feet below the ground surface by means of horse drawn scoops. At this level, walers for the sheeting were placed on the sand and driving started. Excavation was then continued from this level (-4.0) to the bottom (-23.0) inside the sheeting with a clam shell bucket operated from the -4.0 level. The sheeting was driven to elevation -29.0 or about three feet in the clay, thus sealing the cofferdam in good shape. The steel sheeting was left in place as under the conditions it was probably more expensive to pull it than it would have been worth after pulling.

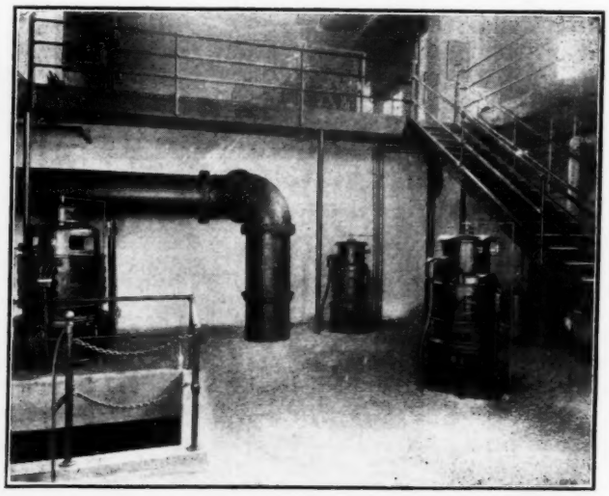
The ground water was taken care of very nicely down to the -4.0 level by means of one 6″ x 10″ duplex plunger pump and one 8″ x 7″ triplex plunger pump, both gasoline engine driven and connected to a total of 100 well points. From -4.0 to -23.0, however, a great increase in ground water was encountered and it was finally necessary to secure more well points and more pumps as well as lowering the pumps and points already in use. The total pumping equipment in use when at the bottom of the excavation consisted of two hundred 1¼″ well points, three 8″ x 7″ triplex pumps, one 6″ x 10″ duplex pump and one 2″ centrifugal pump, all gasoline engine driven except the centrifugal which was electric driven. The centrifugal pump was placed in a sump at the bottom of the deep excavation and was used intermittently. Some difficulty was had with the well points clogging up at the low level, as the ends of them were sunk to clay and became clogged with the material. When all the excavation had been finished, 4″ farm tile drains were placed in gravel around the perimeter of the dry and wet wells, all of which led to a sump from which the centrifugal pump drained the water. In this way the bottom was kept very free of water. The well points system was of the usual type consisting of fifty 1¼″ well points per pump attached to a 4″ header pipe by means of flexible hose connections with each point controlled by a separate valve.

It will be interesting to note that the water line stood at an angle of about 45 degrees from the bottom of the excavation outside of the sheeting. This was noted when the trench for the influent connection was being dug. The latter trench was dug in open cut. Water did not give any trouble here as the sewer invert was four feet above the wet well, although it was necessary to use well points on each side of the ditch as the water did not flow freely through the sand.

The steel sheeting was braced from side to



TWO 50 M. G. D. STORM WATER PUMPS



MOTORS FOR THREE VERTICAL UNITS. PUMPS ARE IN DRY WELL BELOW

side by 10" x 10" and 12" x 12" timbers spaced vertically about seven feet apart. When the concrete walls were poured, it was necessary to box around these timbers and later grout up the hole in the wall.

The connection to the old brick influent sewer was made by excavating completely around the old sewer and encasing the latter with new concrete. The concrete underneath the old sewer was placed a little at a time so as not to leave too great a section unsupported. When the new station was ready to be put in operation the incoming sewage was kept as low as possible (18 inches deep) and then the side of the old sewer was broken out, working from inside the new connection.

The excavation was begun about June 1 and sheeting and excavation finally completed July 30. The first concrete in the bottom of the dry well was poured July 22 and the bulk of the concrete was all in place by Sept. 3. Nothing of any special interest is to be noted during the progress of concrete or brick work. A poured gypsum roof was used as recommended by the U. S. Gypsum Company and proved easy to place and made a good roof. The building was roofed in by Nov. 14 and during November and December the pumps and other equipment were installed.

The plant was put into regular operation December 23, but was not finally completed in every detail and equipment properly adjusted until Feb. 15, 1926.

The station was designed by J. G. Mellish, of the firm of Pearse, Greeley & Hansen and the construction was supervised by the writer. The general contractor was E. P. Strandberg Co. of Chicago.

STAND-BY GENERATING SET FOR EMERGENCY USE

Pulverized Fuel in Water Works Plants

Des Moines water works pumping plant tried pulverized fuel under one of its boilers and is now installing a second unit. Details of pulverizer and boiler.

The advantages of pulverized coal, based largely upon experience with it under one of the boilers of the Des Moines, Iowa, water plant, were explained at the convention of the American Water Works Association by Charles S. Denman, general manager of the Des Moines Municipal Plant. He prefaced his remarks with a brief review in which he stated that within the past five years the modern power station has undergone and is now undergoing a process of evolution. One feature of this is the use of pulverized fuel, which has come into general practice during the past ten years.

Most of the enormous waste in thermal efficiency that exists in most plants can be overcome by pulverizing the fuel, the chief advantages of which are:

Higher thermal efficiency.
Wide range of fuel that can be used.
Flexibility.
Ease of control.
Elimination of necessity for banked fires due to enormous furnace volume.
Little ash and clinker.
Almost complete combustion.
Reduction in amount of excess air.
Almost absolute control of air supply.
Chimney losses reduced.
When furnaces are properly operated and designed, almost complete elimination of smoke.
Lower furnace maintenance costs.
Automatic damper and feed control.
Saving in labor.
Higher boiler rating.
Lower necessary capital expenditure for buildings and boilers.

"The ideal fuels for use in pulverized form are undoubtedly those of the higher calorific and volatile content and those low in ash. Nevertheless the only question involved in burning pulverized fuel is the price of the fuel. Anything can be burned that has any

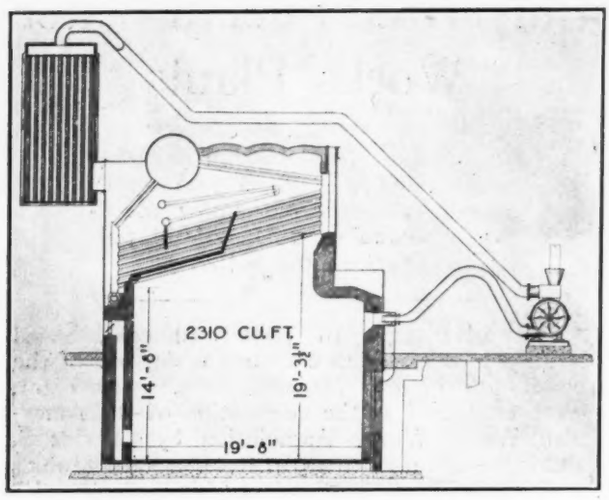


DIAGRAM OF BOILER WITH PULVERIZER

heat value regardless of the quantity of volatile matter, sulphur, ash, etc. Mine waste is now beginning to be reclaimed and used. In portions of the country low grade lignites are used."

"The average overall thermal efficiency of a hand-fired steam boiler at about 55%, when good coal is used, may sometimes be increased to 75% with best conditions and a particularly skillful firemen. . . . The average thermal efficiencies on chain grate stokers burning high-ash low-grade coal is from 55 to 75%."

Mr. Denman described his experience as follows:

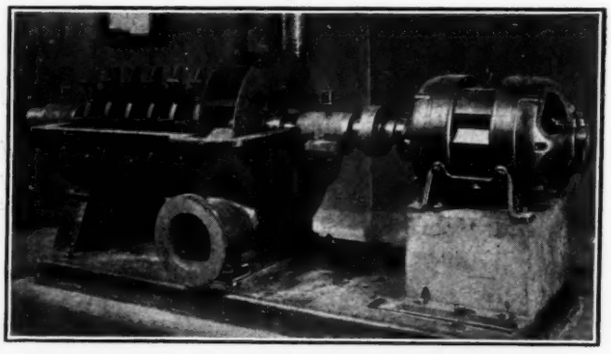
In November, 1925, we put into operation in connection with one of our boilers at the 21st Street pumping station in the city of Des Moines a unit pulverizer which was designed and built by our chief mechanical engineer, George A. Conrath, a member of this association who was formerly with the Bethlehem Steel Company at the Cambria Plant where he had some considerable experience with pulverized fuel. This machine differs in many respects from any other that we know.

The pulverizer has an automatic feeding device which is belt driven from the main shaft of the unit. This shaft is 3½" in diameter with six sets of ordinary low-carbon steel rotors. There are six impact hammers on each rotor. The impact hammers are made from tool steel and heat treated to make them very hard. The casing is made in two pieces, from cast iron, an upper and lower half. There are two compartments, one for the pulverizer, the other somewhat larger in diameter for the fan. The cast iron casing is lined with corrugated chrome steel liners. Between each rotor is fastened on the inner liner reacting or retarding blades. The fan is fastened on the same shaft as the impact hammers thus making the mill a complete unit. The casing is fastened on a bed-plate which is large enough to accommodate a forty horsepower motor which is directly connected to the shaft of the pulverizer.

The coal is burned as received from the mines without being dried. Although not essential, we think better results can possibly be obtained by drying the coal to a moisture content of from one to five percent. Dry coal is easier to pulverize and burns more effectively.

A belt-type magnetic separator is used for the removal of tramp iron from the coal. As a further precaution, in the first stage of the pulverizer there is a tramp iron pocket, the rotor in which is made smaller to give it more clearance so that any tramp iron entering the machine will be driven down into the tramp iron pocket. Tramp iron can then be removed at will, thus not causing any interference with the pulverizer.

About twenty-five percent of the air for combustion which is used in the furnace is preheated and admitted with the coal at the feeder. The air which enters the pulverizer casing and the pulverized coal which passes along with it cannot pass directly through the pulverizer casing but must take an irregular course therethrough. This is brought about due to the fact that there are no openings provided in the rotors, and the slots in the adjacent stationary blade members are arranged in staggered relation. Thus some of the air entering the first compartment passes



PULVERIZER WITH TOP OF CASING REMOVED

upward around the rotor, through the slots in the lining separating the first and second compartment, down along the rotor and through the opening in the first stationary blade member. The air passing into the second compartment, in order to pass on to the third, must take a lateral zigzag course through the slots of the second stationary blade member or a vertical zigzag course over the second rotor through the second stationary blade opening. In this manner the air is given a drubbing or scrubbing which insures, by the time it reaches the fan, a thorough admixture of air and pulverized fuel. Any coarser particles, which may tend to pass along with the air are retarded by the impact hammers and stationary blading, thus being left behind for further impact to reduce them to the desired pulverized form.

The boilers consist of four 323 H. P. Springfield cross drum water-tube type with a heating surface of 3,230 square feet, a superheating surface of 700 square feet and a total heating surface of 3,930 square feet. The front wall, back wall and bottom of the furnace are hollow. The

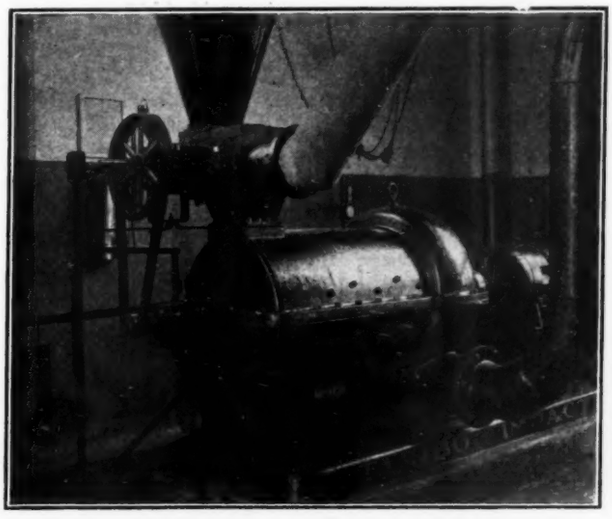
furnace contains 2,310 cubic feet, which is a volume per rated boiler horsepower of 7.15. The baffles are of the three-pass type with a horizontal baffle on top of the second row of tubes from the rear connecting to the front baffle.

The burner is of the jet type, having fan-shaped stationary blades for the purpose of throwing a flame of circular or cyclonic effect.

We have made tests from time to time under various operating conditions and on May 13, 1926, an eight-hour test was made by our men. The coal was weighed and measurements of the water were taken with a V-notch meter. This test showed an average boiler efficiency of 81.05%. 6.18 pounds of water were evaporated per pound of coal consumed as fired. The undried coal was fed from the bunker to the pulverizer.

An additional economy is effected during banked boiler hours due to the fact that banking conditions when operating with pulverized fuel are different from those attained in stoker practice. By stopping the fuel and closing the dampers and auxiliary air inlets, the boiler is made similar to a thermos bottle and steam pressure can be held up for several hours. The furnace brickword having been heated to incandescence during operation gives off a radiant heat which is almost all absorbed by the boiler rather than escaping up the stack. The boiler has many times actually stood for a period of from 12 to 14 hours and then put back on the line in from 5 to 8 minutes. Also, when it has been off the line for a long period and become absolutely cold it has been put back into service in 20 minutes.

The coal found in Iowa is one of the lowest grades in the United States. The average B. T. U. per pound of 361 samples as analyzed in our laboratory in 1925 was "as fired" 7998. Of these samples 349 were Iowa coal, 10 samples were from Franklin County, Illinois, and two samples were mixed Iowa and Illinois coal. On the "as fired" basis, the above coal had an average ash content of 19.02%, moisture 21.13% and sulphur 4.58%. Under stoker operation the average percent of combustible in the ash residue for the year 1925 was 10.23 and the percent of combustible matter in the refuse material at the base of the stack was 14.40. Compared to this the percent of combustible in the ash under pulverized fuel operation was 0.6 of one percent.



VIEW OF PULVERIZER IN OPERATION

We are so thoroughly convinced of the manifest advantages and savings that are being obtained that we have built and are now installing a second unit and as soon as expert tests have been made verifying our expectations, it is our intention to remove the present stokers and convert the plant entirely to the use of pulverized fuel. This second unit is driven by a steam turbine and the exhaust steam from this turbine is to be used in drying the coal.

Replacing Steam Pumping With Electric

Small Connecticut water company find electric centrifugal pump much more economical than the steam triplex which it replaced.

By F. B. Northrop*

Starting in 1895 with less than 50 customers, the Millbury (Conn.) Water Company and the community it serves have grown until over 700 customers now receive water from our mains. Consumption is steadily on the increase.

The water supply is pumped from a well 20 ft. in diameter and 35 ft. deep, supplied from small storage basins which feed into the well by gravity, and lifted into a 1,500,000 gal. storage reservoir against a 310-ft. total head.

Until 1915 we used a 12"x12" triplex pump, capacity 720 g. p. m., driven by a 150-hp. steam engine. Steam was generated in two 150-hp. boilers. About that time increasing coal prices and a favorable power rate led us to the consideration of a centrifugal pump, and in 1915 we installed a 2-stage Goulds centrifugal, direct connected to a 3-phase, 550 volt, 1,800 r.p.m. Westinghouse induction motor. This pump has a capacity of 900 g.p.m. against a 300 ft. head, and 750 to 800 g.p.m. against a 330 ft. total net head.

After this pump was installed we used the triplex pump merely as a reserve unit. The centrifugal pump enabled us to lay off one man (the fireman-engineer), cut our power cost, and practically eliminated repair bills.

In 1920 we installed a second Goulds pump, a duplicate of the first, and scrapped the triplex pump. This second pump was set 10 ft. lower than the first one, for use during periods of low water. The first pump has a suction lift of 10 to 24 ft. depending upon the height of the water in the well.

Every two months we drain the oil, wash the

*Superintendent Water Co., Millbury, Conn.

bearings, and renew the oil. Every six months the packing is renewed. The only attention given the pumps is to start one of them each morning. During the rest of the day there is usually no one at the station. An automatic switch operated by an alarm clock stops the pump after a predetermined number of hours.

The accompanying table shows the water pumped during a year before the first centrifugal pump was installed, the coal burned, and the hours pumped; also the water pumped and hours operated during a year when only the centrifugal pumps were used.

The total cost of operating the centrifugal pumps amounts to but $2.01 per hour. This figure includes power and the fixed charges on both pumps. The total cost per year is $4,969.84 which amounts to $.0373 per 1,000 gal. pumped.

One Year's Pumping with Steam and with Electricity

	Centrifugal Pumps		Steam Triplex Pumps		
Months	Thousands of gallons pumped	Hours	Pounds of Coal used	Thousands of gallons pumped	Hours
Jan.	12,960	240	58,600	6,646	159
Feb.	10,206	189	58,100	6,354	153
Mar.	11,934	221	53,800	7,000	168
Apr.	10,368	192	49,800	6,375	153
May	12,474	231	45,800	5,979	144
June	11,988	222	48,900	6,562	157
July	10,152	188	48,800	6,885	165
Aug.	12,312	228	46,400	6,354	152
Sept.	11,016	204	55,500	7,396	178
Oct.	10,800	200	56,900	7,042	169
Nov.	8,856	164	59,100	7,229	173
Dec.	10,160	190	67,800	7,604	183
Totals	133,226	2,469	649,500	81,426	1,954
Average pumped per day		365	Average per day		223.1
Maximum. per. day (June 30)		864	Maximum per day		541.7
			Lbs. of coal per 1,000 gal. pumped		7.98

Comparison of Costs

Cost of Operating Old Plant; Based on Present Water Requirements

Depreciation—$18,000÷20 year's life	$900.00
*Average interest @ 6%—$\frac{21}{20}$ x $18,000 x $\frac{.06}{2}$	567.00
Allowance for repairs, etc.	600.00
Total fixed expense	$2,067.00
Wages of one engineer—fireman—$6.00 per day x 365 days	2,190.00
Coal—133,226,000 gals. x 7.98 lb. per 1,000 gals. x $10.50 per ton	5,581.50
Total cost per year	$9,838.50

Cost of Operating Two Centrifugal Pumps

Depreciation—(2 pumps) $3,349.00÷20 years' life	$167.45
*Average interest at 6%—$\frac{21}{20}$ x $3,349.00 x $\frac{.06}{2}$	105.49
Repairs and maintenance, actual	59.88
Oil and waste, actual	12.02
Total fixed cost per year	$344.84
Power (actual cost @ $.0185 per kw.-hr.)	4,625.00
Total cost per year	$4,969.84
Cost per 1,000 gallons pumped—$4,969.84÷133,226	$ .0373
Cost per pumping hours—$4,969.84÷2,469	$2.01

*Allowing for interest earned by depreciation reserve.

If we were using the old plant, the fixed charges on boilers, engine, and pump would amount to $2,067 annually, the wages of the operator would be $2,190, and coal would amount to $5,581.50, making a total cost of $9,838.50 per year. Our centrifugal pumps therefore save us $4,868.66 per year—a return of 145% on the investment.

In calculating the fuel consumption of the triplex pump we have multiplied the former consumption of 7.98 lbs. of coal per 1,000 gal. by the quantity of water pumped during the year for which the centrifugal pump costs were figured. Since more water was pumped during this year, it is probable that a slightly lower unit coal consumption should be used, but the error introduced could not possibly affect the net saving by more than a few hundred dollars.

In addition to the saving in operating expense, we now have less breaks and leaks on our pipe lines because of the steady pressure maintained by the centrifugal pumps. The possession of two pumping units insures our ability to provide continuous service. When fires occur the electrical drive is of particular advantage, for it permits starting on very short notice.

Sewer Maintenance in Waltham

The Sewer Division of the Department of Public Works of Waltham, Mass., makes an annual report on the form recommended some years ago by the Sanitary Section of the Boston Society of Civil Engineers. In giving the information relative to flushing, cleaning, etc., the report makes the following statement:

Method of flushing: When hydrants are within 100 feet of flushing manholes, use 2½ inch hose. Elsewhere use direct connections with the water mains.

Methods of cleaning: Rope, chains, followers and scrapers of different kinds.

Number of direct connections with water mains for flushing..... 124

Number of flushings and cleanings of entire system during the year..... 1

Number of stoppages..... 15

Miles of permanent underdrains..... 0.57

Method of ventilation: Through connections to house roofs.

Cost of maintaining sewer system exclusive of disposal works (including cost of flushing and cleaning sewers, administration and unclassified expenses).....$4,094.49

George C. Brehm is director of the department and city engineer.

Highway Lighting in Florida

What is said to be the largest installation for highway lighting in the country has been put into service in Florida for lighting the 19 miles of highway from South Jacksonville to Neptune. G E. Novalux highway lighting units are used, equipped with 400 c. p. lights. The county commission turns on these lights at the same time those of South Jacksonville go on and they burn until midnight.

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Materials Used for Sewers

The younger generation of engineers can scarcely realize the fact that forty years ago concrete had been used for sewer construction in only a few cities and as an experiment, while segment blocks were not invented until years later. The engineer then relied on vitrified or machine-made cement pipe (not reinforced) for sizes up to twenty-four or thirty inches, and brick of stone masonry for larger sizes, with occasional use of cast iron and wood. Now stone masonry for sewers is a thing of the past and brick is seldom used except occasionally for lining inverts.

The development of concrete has permitted great improvement in sewer design and construction and increased rapidity of construction. To lay a circular brick sewer with every brick joint radial required a "knack" and practice and men possessing these were not always available, as a result of which most brick sewers were more or less rough. At its best a brick sewer had a rougher inner surface than has a concrete one made against a smooth form. The enormous number of joints in brick work also resulted in much more permeable walls than those of reasonably good concrete. The tables in this issue would indicate that very few brick sewers are being built now, although they may still be cheaper in sections of the country where brick clay is abundant and rock or gravel and sand are scarce.

It would seem somewhat inconsistent to continue the use of brick for manholes after it has been discontinued for sewers. The building of brick manholes require even more special skill than building brick sewers, and brick manholes are often found admitting ground water to sewers otherwise tight. It is true that concrete manholes require the use of forms, but two or three sets of light steel forms would suffice for an entire sewer system, since practically all manholes are alike except for depth and this could be provided for by a few telescoping sections of forms.

Cast iron has always been used for manhole heads and seems to meet all requirements, unless a stronger steel cover might be desired to support the wheels of heavy modern trucks. Cast iron has for years been used for street inlet heads, and of late many cities have used with satisfaction entire inlet basins as well as heads made of this material and installed as a unit.

Vitrified clay has maintained its popularity for pipe sewers up to twenty-four inches or larger, and the same material as segment blocks or as plates for lining concrete sewers is finding wide use. For jointing vitrified pipes the use is increasing of materials other than cement by which the possibility of leaking joints can be greatly reduced. Tightness of sewers is becoming of great importance, especially where sewage must be treated or pumped or both. It is practically impossible to remedy leakage that exists generally throughout a sewer system and the expenditure of a considerable sum in securing tightness of construction is generally justifiable.

Assessing for Public Improvements

The practice of assessing against abutting property the cost of paving or other public improvements seems to us unjust and indefensible, although so common that property owners have come to accept it without question.

The law requires an assessment for an improvement to be distributed in proportion to the benefits conferred thereby, and then accepts the ridiculous assumption that these benefits are proportional to the frontages of the abutting properties (or occasionally their areas) and to the cost of the improvement.

An 8-inch sewer would abundantly serve the needs of myself and neighbors; but if the engineer's plan calls for a 24-inch line past my property to carry the sewage of a larger area above me, I must pay my share of this sewer instead of an 8-inch; and should I be so unfortunate as to own a corner lot and a sewer be laid past it on the side street also, I must pay for this in addition although it is of absolutely no benefit to me.

Assessing for sewers is not so common as for paving, but the principle in the case of both is the same. My benefit in the pavement in front of my property is confined to its affording comfortable access to my house for the automobiles of myself, my friends and merchants delivering goods to me. The most inexpensive bituminous macadam would serve this purpose with very little wear for years. If, however, I live on a thoroughfare over which hundreds of vehicles pass each day, a pavement costing several times as much is assessed against me, although the additional traffic is not a benefit but is on the other hand a nuisance, endangering the lives of my children and affecting the nerves of my wife by the noise and confusion.

A year ago it was decided to lay out a new cross street, and the line selected is along the side of my property. I did not buy a corner lot, do not want one, and the new street is no benefit to me, but I am assessed for grading and paving it.

The reply is sometimes made that no law for all the people can be devised that will not work an occasional injustice. But here we have the **justice** occasional; for the assessments for a given class of public improvements in any city only very seldom and by chance are proportional to the real benefits derived therefrom.

An article in the July issue of **Public Works** discussed the matter of assessments on corner lots. Some prefer corner lots and are willing to pay a little more for them, but that hardly seems any more logical a reason for charging them an additional amount for furnishing them with facilities for access to the property and for removing sewage from it than for charging them more for garbage removal or educating their children.

As a matter of fact, we believe, the policy of assessing the cost of public improvements was adopted not because of any idea of justice but as the easiest way to raise the funds for carrying on the improvement. Years ago, when the amounts spent for public improvements were not a quarter as much per capita as today, most of them were paid directly from the public treasury. As the cost of street improvements—the largest item—increased, the higher taxes became unpopular and, to avoid antagonizing the voters, officials adopted the plan of assessing the cost against the few whose properties were most evidently benefitted. As practically only one kind and price of pavement was then used throughout a given city and corner lots were not assessed for paving the side streets, there was not so much injustice as now and, accepting the plea that the improvement could not be put through unless the abuttors would pay for it, the plan was accepted. But it was not founded on justice, and as it has developed, the injustice has increased.

The gasoline tax is generally accepted without a murmur where the proceeds are used for roads, because it is recognized as perhaps the fairest way of assessing the cost of them in proportion to the benefits derived from them. A "wheel tax" or other form of vehicle tax would seem to be the fairest way of raising funds for city streets; but if this is not deemed practicable, there are other methods that approximate much more nearly to fairness and justice than that of assessing a man for paving the streets an amount proportional to the use made of them, not by himself but by others.

Papers for Society Conventions

Many engineers and other public works officials who have attended conventions have been more or less impressed with the appearance on the program of papers which appear to be a waste of time of most of those present, and practically all secretaries and committee chairmen of technical societies fully appreciate the difficulty of arranging programs which will give the greatest amount of benefit to the largest percentage of the membership, this involving refusing some papers that are submitted and using every endeavor to obtain papers on other subjects from other individuals who lack both time and inclination to prepare the same.

The League of California Municipalities uses a method of partly solving the problem of convention papers which, it seems to us, might well be adopted by other societies. The League's constitution contains the following provision: "Prior to each annual convention the Executive Secretary shall send out to the city officials a questionnaire ballot containing the titles of subjects for the program and requesting the officials to mark thereon their first, second and third choices and return them to League headquarters. So far as practicable, the program shall be prepared according to the returns thus received."

This year the subjects voted upon, arranged in the relative order of votes received from the members (this society is composed of all classes of city officials) were as follows: Zoning, Sewer systems, Building codes, Pavements, Set-back lines, Business licenses, Budget systems, Street lighting, Garbage disposal, Traffic problems, Division of gasoline tax,

Public spirit, Advertising a city, Fire protection, Bill board regulation.

In classifying the votes, each first choice was counted as one, each second choice as one-half and each third choice as one-third, and the total for each subject was taken as the sum of the votes thus weighted. So apportioned, Zoning received 38 2/3 votes, Sewer systems, 27 1/3 and so on gradually decreasing down to Bill board regulations which received 9¾ votes. Other subjects received a smaller amount of votes and apparently were not considered, among these being Parks and playgrounds, Street ornamentation, Municipal markets and a few others.

The convention referred to by this questionnaire is to be held from August 16th to 20th and in the May issue of Pacific Municipalities, the official organ of the League of California Municipalities, the result of this questionnaire was published and the statement made that "The program will be arranged, so far as possible, to devote the time of the convention to the above named subjects in the order set forth."

The Coos Bay Filter Plant

The following information concerning the filter plant of the Coos Bay Water Company is furnished to us by R. H. Corey, general manager of the company. The plant, which is located at Mansfield, Ore., was put into operation about the first of May.

"The raw water has vegetable stain color varying from 25 to 140 U. S. G. S. scale at different seasons, with pH values from 5.7 to 6.8 at different times. The hardness is usually around 16 parts per million but also varies considerably. The raw water is quite corrosive, especially in hot water piping.

Alum and lime are added at the pumping station, mixing with the water as it passes through the pumps and delivery main. Chlorine also is added at the same point. From about 10 to 24 hours' sedimentation is given the water and then passed through six pressure filters. After which a suitable addition of lime is made to raise pH values to around 7 to stop corrosive action. After which the water is aerated through spray nozzles. The resulting water at the faucet has a hardness of about 24 parts per million, being changed from an acid to alkaline condition. The color has been reduced to 5 or less at the faucet. Rust tubercles on the inside of piping so far seem to be hardened as they do not break up and come through with the water as much as formerly. The results obtained so far from the operation of the new plant seem to be satisfactory. The filter equipment was installed by the California Filter Co. of San Francisco and Seattle.

New Features of Water Purification Practice in Ohio*

Research studies and experiences of several Ohio water purification and softening plants in pre-chlorination, doube coagulation, excess lime treatment, adjustment of pH values, lime-soda and zeolite softening, and iron removal.

By F. H. Waring†

PRE-CHLORINATION

Treatment of raw waters with chlorine is not a new procedure. There are, however, some new phases of this treatment that are being experimented with in Ohio. Studies are now being conducted at the Akron plant in the attempt to eliminate a troublesome gas-forming organism that survives the usual filtration and chlorination treatment. The first part of the research involves the application of liquid chlorine in limited amount into the raw water conduit at the impounding dam about one-half mile from the filtration plant. The chlorine applied will be limited to an amount such that no residual chlorine is present in the water entering the mixing chambers. The second phase of the research involves application of heavy amounts of chlorine at the initial point, followed by de-chlorination using sulphur dioxide at the mixing chambers. Results of these studies will not be available entirely until about October of this year.

Another research with chlorine application to raw water has been under way for almost a year, the work being started at Ironton and continued at Sandusky. The purpose of chlorine application in these instances is to relieve the extremely high bacterial load upon the ordinary purification processes. The chlorine application experiments are being conducted in two ways in a manner similar to that described in the Akron case; first, a mild treatment leaving no residual chlorine in the water passing to the coagulation basins; and second, heavy chlorination followed by de-chlorination before the water is coagulated. Ironton has a yearly average B. Coli content of about 16,000 per 100 c.c., with daily peaks as high as 100,000. Sandusky has considerably less pollution load, the yearly average being about 1,500 B. Coli per 100 c.c., with daily peaks of 10,000. The Ironton experiment has proved a failure on account of the presence of industrial wastes containing phenol in the Ohio river water, giving rise to chloro-phenol tastes that made the use of chlorine impossible in the water treatment; hence the activities have been transferred to San-

*Part of paper read before the Water Purification Division of the American Waterworks Association.

†Chief engineer Ohio State Department of Health.

dusky, where no phenol wastes are expected to interfere. From the bacterial standpoint the Ironton experience indicates that chlorine may be utilized to relieve the heavy pollution load and not interfere with subsequent processes, if no residual chlorine is left in the water coming to the coagulation basins.

ADJUSTMENT OF pH VALUE FOR OPTIMUM COAGULATION

The operators in this state have studied the raw water conditions with a view to determining the optimum pH value for coagulation. Generally speaking, not a great deal of difference seems to prevail in Ohio waters between the raw water pH value and its optimum for coagulation. However, two or three of the plants dealing with impounded reservoir or lake waters have felt that it was promising to research along lines of reducing the pH value in the raw water before coagulating. E. E. Smith, superintendent of filtration at the Lima plant, has had in service for approximately one year devices to apply carbon dioxide gas to the raw water as it enters the filtration plant and prior to application of the coagulant. The treatment was begun as an experiment and has been so successful that the equipment first installed has been kept in regular use, and the city is now taking steps to provide permanent and more efficient equipment. The yearly average pH value of the raw water is about 8.0. The average optimum pH value for coagulation is found to be about 7.0. The carbon dioxide applied reduces the pH value by about 0.3 and accomplishes a reduction in coagulant required of about 0.5 grain per gallon. The treatment has been limited to the above extent by reason of the undesirability of increasing the free carbon dioxide content of the filtered water, in order not to produce a condition of corrosive water. The plant is not adapted conveniently either for pumping the filtered water to aeration devices, or for secondary treatment with lime to correct the corrosive tendency of the final effluent; however, it is expected at a latter date that this feature will be remedied in order that even greater savings may be obtained in coagulent application by first employing carbon dioxide gas to bring about the reduction in pH value of the raw water.

DOUBLE COAGULATION

The term double coagulation has been applied to the use of two series operated coagulation basins with separate mixing chambers or devices to bring about coagulation in each basin. At the present time two Ohio filter plants have been rearranged to accomplish double coagulation (Portsmouth and Cincinnati); two plants were constructed new including this feature (Ironton and Toronto); and one plant is under construction utilizing series operated coagulation units (Norwalk).

There are two prime reasons for the tendency to use double coagulation in Ohio. (1) Ohio river carries a load of bacterial pollution that is too heavy for ordinary water purification processes employing one stage of coagulation; that is, the final effluent is made safe only because a great burden of purification rests upon the final process of chlorination. During the past two or three years industrial wastes containing phenol have seriously interfered with the use of chlorination for Ohio river water and hence it has become necessary to resort to other means, at least for considerable intervals of time. (2) A few reservoir waters in this state contain considerable amounts of color and have relatively low alkalinity. Double coagulation devices furnish excellent opportunity for coagulation of the color under these conditions, since any desired amount of alum may be applied alone in the first basin; lime may then be applied in the secondary basin to precipitate any free aluminum and to nutralize the corrosive condition of the water. The foregoing practice, while new in this state, has been copied from the experiences of the Wilmington, N. C., plant as reported by Messrs. Catlet and Norcom.

EXCESS LIME TREATMENT

The term "excess lime treatment" has been given to the water treatment practice which includes the application of enough lime to the raw water to create a caustic alkalinity. Such is the practice at water softening installations for the purpose of bringing about the water softening reactions.

It was observed by C. P. Hoover, soon after the Columbus plant was placed in service, that the causticity thus obtained created a condition unfavorable to bacterial life, and that the effluent from the settling basins was sterile. At his suggestion Youngstown instituted the excess lime treatment for the badly polluted Mahoning river water used as a source of supply at that plant. That the treatment has been a success is demonstrated by the experience of the last few years. The raw water pollution load at Youngstown is probably the greatest of any water treatment plant in the country; the yearly average B. Coli index exceeds 20,000 per 100 c.c., and it is not possible to use chlorine at this plant because of interference by phenol-bearing wastes. The final effluent during the past year has not shown a single positive presumptive B. Coli test in any of the five 10 c.c. portions tested daily. The safety of the water is entirely dependent therefore upon careful application of lime to the river water, and W. I. VanArnum, superintendent of the Youngstown plant, deserves great credit for the careful conduct of this lime treatment.

COMBINATION OF EXCESS LIME, DOUBLE COAGULATION, AND ADJUSTMENT OF RAW WATER pH VALUE

Following the unsuccessful attempt at Ironton to relieve the bacterial load in Ohio river at that point, a change of treatment was made beginning in December, 1925. The experience of Youngstown and Lima has been made use of at Ironton in the following schedule: The plant has double coagulation facilities; accordingly, lime was applied to the primary basin in an amount to produce causticity, therefore sterilizing the supply. Alum was applied at the secondary basin to coagulate the turbid Ohio river water. It was noted that considerable alum was required if the influent water to the filters was to be kept in a condition to prevent carbonate scale forming on the sand grains as a result of the excess lime used. In order to economize on the alum, the pH value of the water is being reduced by the use of carbon dioxide gas applied at the mixing chamber of the secondary basin. A saving of more than two grains of alum per gallon seems to be promised and the water coming to the filters contains no monocarbonate alkalinity that would encrust filters or piping beyond the plant. By means

of the practice above related it will be possible to produce excellent filtered water without the use of any chlorine; without increasing the cost of the water treatment over previous practice; and having as reserve processes, or factors of safety in the treatment, both the coagulation in the secondary basin and the rapid sand filtration.

LIME-SODA SOFTENING PROCESS FOR SMALL MUNICIPALITIES

Experience in the industrial field has been copied and applied in convenient manner at two small municipal softening works in this state, where the fill-and-draw system of water softening is used. The settling basin also constitutes the mixing tank, the mixing being accomplished in one instance (Glendale) by mechanically operated agitators and in the second instance (Batavia) by compressed air. The charge of chemicals is applied while the tank is filling with water. Fundamental principles of water softening are taken advantage of, in that mass reaction of the chemicals with the water is obtained; efficient mixing by mechanically operated agitators takes place; and a perfectly quiescent settling condition prevails, because the tank is allowed to remain idle before water is drawn off to the filters from the surface by a floating outtake. It has been our experience that the fill-and-draw system of softening by the lime-soda process is better adapted for the very small plant than the continuous flow system.

MUNICIPAL ZEOLITE SOFTENERS

The employment of the zeolite process for municipal water softening is of fairly recent occurrence in this state. One plant is under construction for a small community, and two others are proposed for immediate installation. Advantages of this process over the lime-soda process are pronounced in the case of the small community which already has an adequate supply of well water of good sanitary quality. Some of these advantages are the following: By operation of convenient bypasses any degree of hardness desired may be permitted in the final product; the installations are compact; they are considerably cheaper to install; operation costs are about the same; and very little supervision is required.

NATURAL RECARBONATION

Oberlin has the oldest municipal water softening installation in the country utilizing the lime-soda process. Incrustation and depositing of carbonate of lime have occurred extensively in the distributing system. The excelsior filters originally provided were abandoned last year when Oberlin began the practice of natural recarbonation, which was made possible by the use of an existing large open reservoir for the storage of the treated water. Chlorine is applied to the final product delivered to the system as a factor of safety on account of the open storage of the treated water. The results have indicated that enough carbon dioxide is absorbed from the atmosphere in the 30 days or more of storage to furnish a stability of softening reactions. Although all of the normal carbonates are not converted by this atmospheric absorption, it appears that the depositing portion of these carbonates is eliminated. It is too soon to state if the open storage of such water will not invite other difficulties such as algal growth.

IRON REMOVAL AND SOFTENING

Ohio has about 15 iron removal plants in which ground water is treated. The original devices used were aeration, sedimentation and rapid sand filtration. The fundamental principles involved in iron removal practice, as regards Ohio conditions, have been well stated by A. E. Kimberly in his paper published in the Second Annual Report of the Ohio Conference on Water Purification, as follows: (1) The water must be thoroughly oxidized to precipitate the iron. (2) Some of the precipitated iron is colloidal in character but may be coagulated by catalytic action in contact with previously precipitated iron sludge. In the newer types of plants, therefore, sedimentation is being abandoned in favor of contact filters.

At one recently completed plant (Newton Falls) the devices are placed one above the other, on what might be called the "skyscraper" plan. The water from the wells is pumped to nozzle aerators located at the top of the structure, which spray directly upon the contact filters, from which the water flows to the sand filters at the first floor level; the effluent from the sand filters is collected in the clear well substructure.

At another plant it is proposed to substitute for the silica sand in the rapid sand filters zeolite sand, in order that the water may be softened in addition to the iron removal. The experience of the past year would seem to show that contact filters are very efficient in bringing the iron out of solution and in removing the greater portion of the iron. Therefore, the use of the zeolite in place of the filter sand should result in satisfactory softening without the zeolite being interfered with by iron depositing around the zeolite particles.

There is a general trend toward municipal water softening in all new development of water treatment in Ohio. It seems that our people are requesting a soft product as well as a pure product and this requirement appears to be independent of whether the water supply is of surface origin or of ground water origin.

CONCLUSION

In conclusion, the writer wishes to state that the material presented in this paper is drawn largely from the work of the Ohio Conference on Water Purification and credit for new thoughts gleaned belong to the men in charge of the particular plants cited. This conference comprises the men actively in charge of the water treatment plants; they have met with the State Department of Health annually for the past five years, and the conference has thus become the medium of exchange of ideas, experiences, and the results of research studies.

"Simplified Practice" in Public Works

The Department of Commerce has issued a statement summing up some of the results of its efforts to secure simplified practice in all branches of industry in the country, especially so far as simplified

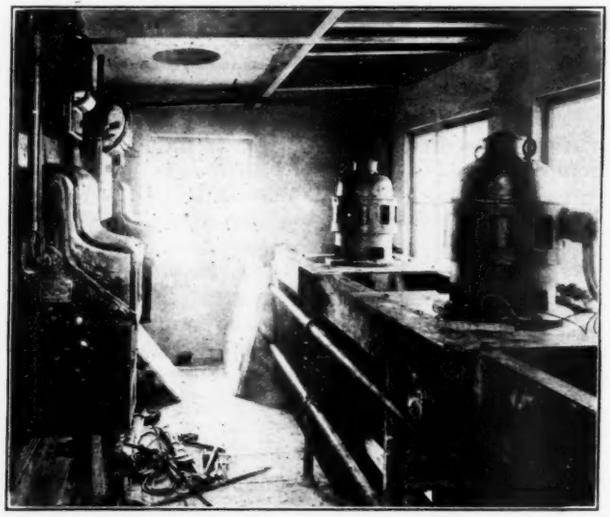
practice means the reduction of the number of varieties of a given product that are placed on the market. The summary lists forty different items in which the number of varieties manufactured have been reduced to a greater or less extent and 17 in which the recommendations are in the process of acceptance. Comparatively few of these are of immediate interest to public works engineers or contractors, except as these may be interested in the construction of buildings involving the use of lumber, building brick, roof slates, etc.

Among the items directly involved in public works, vitrified brick leads with a reduction of varieties from 66 to 4 or 94%. Next we have asphalt, the penetrations of which have been reduced from 88 to 9 or 87%. In connection with concrete pavement we have steel reinforcing bars, cross sectional areas of which have been reduced from 40 in number to 11 or 73%. Among the recommendations in progress of acceptance is one to decrease the variety of shovels, spades and scoops from 5,136 to 2,178; and one for reducing the sizes of wrought iron and wrought steel pipes from 64 to 42.

Pumping Storm Water at Grade Crossings

Automatic pumping stations, for the collection and disposal of storm water, were installed jointly by the Detroit, Toledo and Ironton Railroad and Wayne County, Michigan, for operation at seven of ten highway grade crossing separations just completed on its northern division. These stations were designed to solve the problem of adequate storm water drainage from pockets in the road resulting from depressing the highway.

Concrete pump houses were erected containing electrically driven pumps operating from local power lines. Concrete sumps sunk about 15 feet below the pavement collect the water from catch basins located at intervals along the line of the depressed highways, from which the water flows through vitrified tile drains. The pumps lift the water into other basins set a little below railroad grade but sufficiently elevated to allow a gravity flow through vitrified pipe into drainage ditches constructed under the tracks.



INTERIOR OF PUMP HOUSE, SHOWING MOTORS COUPLED TO PUMPS OVER THE SUMPS

American Well Works pumps are used at six of the crossings and all the pump houses are equipped with General Electric motor drive with automatic control. A typical installation consists of two 8-inch centrifugal pumps within the pump house, which empty a 17,800-gallon sump. Each pump has a capacity of approximately 860 gallons a minute and is driven by a 10-horsepower motor having a double squirrel-cage rotor.

Float switches in the wells control the pumping motors throughout magnetic switches. The pumps supplement each other, one or both being thrown into action as the level of the water rises. They are automatically thrown out of service as the water recedes in the sump. Maintenance costs are reported by the railroad to be comparatively small.

State Highway Testing Laboratories

Facilities of the testing laboratories operated by the several state highway departments.

Some facts and figures concerning the testing laboratories operated by the several state highway departments have been compiled by the U. S. Bureau of Public Roads and from them we have prepared the accompanying table. These data refer to the year 1925.

All but three of the states operate more or less complete laboratories of their own, and these three use commercial laboratories. In classifying the laboratories the Bureau divided the tests for which the laboratories are equipped into fifteen heads, as named in the table, and stated for each laboratory whether it was fully equipped, partially equipped, or not equipped, for each of these kinds of tests.

The only laboratories fully equipped for all the tests were those of Iowa, Kentucky, Minnesota, Missouri, Ohio, West Virginia and Wisconsin. Those fully equipped except for one partially equipped were Indiana, Louisiana, Texas and Utah. Those entirely unequipped for only one test were Kansas, Pennsylvania and Tennessee.

Counting full equipment for each class of tests as one, and partial equipment as one-half, we obtain the following scores: 15 (full equipment for all)—Iowa, Kentucky, Minnesota, Missouri, Ohio, West Virginia and Wisconsin. 14½—Indiana, Louisiana, Texas and Utah. 14—Connecticut, Kansas, New Hampshire, New Jersey, Pennsylvania, South Carolina, Tennessee and Virginia. 13½—Michigan and Nevada. 13—Illinois, Massachusetts, Nebraska, New York, North Carolina and Oklahoma. 12½—Arkansas and Georgia. 12—Florida and Vermont. 11½—Oregon. 11—Idaho, Maine and New Mexico.

Facilities of State Highway Testing Laboratories

F-fully equipped. P-partially equipped. N-not equipped.

State	Laboratory: Date established	Laboratory: Approx. No. of empl'yes	Laboratory: Approx. No. of tests in 1925	Materials which laboratory is equipped to test: Bitum. mater.	Bitum. mix.	Paving brick	Cem't.	Conc.	Corrugated culv. pipe	Concrete &c. culv. pipe	tile	Gravel	Paint	Rock	Sand-clay, Sand top-soil, etc.	Slag	Steel
Arkansas	1924	1	3,000	F	F	F	F	F	N	F	F	F	N	F	F	F	F
Arizona	1921	4	1,200	P	F	P	F	F	P	N	N	F	N	F	F	F	F
California	1912	16	8,600	F	F	N	F	P	F	N	N	F	F	F	F	N	F
Connecticut	1925	1	1,500	F	F	P	F	F	P	F	F	F	F	F	F	F	F
Delaware	1917	3	3,000	N	N	P	F	F	N	N	N	F	N	F	F	F	F
Florida	1917	4	3,000	F	F	F	F	P	F	N	N	F	F	F	F	F	P
Georgia	1924	6	6,030	P	F	P	F	F	F	F	N	F	F	F	F	F	F
Idaho	1919	1	560	F	F	P	F	F	P	N	N	F	N	F	F	F	F
Illinois	1911	26	16,000	F	F	F	F	F	F	N	N	F	F	F	F	F	F
Indiana	1921	21	60,000	F	F	P	F	F	F	F	F	F	F	F	F	F	F
Iowa	1919	4	1,271	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Kansas	1917	8	1,700	F	F	F	F	F	F	F	F	F	F	F	F	N	F
Kentucky	1915	6	4,300	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Louisiana	1925	4	532	F	F	P	F	F	F	F	F	F	F	F	F	F	F
Maine	1914	3	1,515	F	N	P	F	F	F	P	N	F	N	F	F	F	F
Maryland	1916	2	1,500	F	F	N	F	F	P	N	N	F	F	F	F	N	F
Massachusetts	1921	4	1,500	F	F	P	F	F	P	F	F	F	F	F	F	F	F
Michigan	1913	20	7,085	F	F	F	F	F	P	F	F	F	N	F	F	F	F
Minnesota	1919	15	4,000	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Missouri	1923	15	10,000	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Montana	1919	1	210	P	N	N	F	P	P	N	N	P	N	P	F	P	P
Nebraska	1900	4	2,580	P	F	F	F	F	P	F	F	F	N	F	F	F	F
Nevada	1918	2	850	F	F	P	F	F	F	F	F	F	F	P	F	F	P
New Hampshire	1917	3	2,000	F	F	P	F	F	P	F	F	F	F	F	F	F	F
New Jersey	1909	45	12,000	F	F	F	F	F	P	F	F	F	F	F	F	P	F
New Mexico	1924	4	1,300	N	N	P	F	F	P	F	F	F	N	F	F	F	F
New York	1909	13	11,430	F	F	N	F	F	F	F	F	F	F	F	F	N	F
North Carolina	1921	25	4,000	F	F	N	F	F	F	F	F	F	F	F	F	N	F
North Dakota	1923	2	820	N	N	N	F	F	P	F	F	P	N	P	F	N	F
Ohio	1909	10	15,000	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Oklahoma	1924	10	7,000	F	F	F	F	F	F	N	N	F	F	F	F	F	F
Oregon	1919	3	2,000	P	F	N	F	F	F	F	F	F	F	F	F	P	F
Pennsylvania	1914	59	30,000	F	F	F	F	F	F	F	F	F	F	F	F	N	F
Rhode Island	1922	3	2,000	F	F	N	F	F	P	N	N	F	N	F	F	P	F
South Carolina	1923	2	5,000	F	F	P	F	F	F	F	F	P	F	F	F	F	F
South Dakota	1921	2	500	N	N	N	F	N	P	N	N	P	N	P	F	N	N
Tennessee	1920	30	12,000	F	F	N	F	F	F	F	F	F	F	F	F	F	F
Texas	1914	4	2,400	F	F	P	F	F	F	F	F	F	F	F	F	F	F
Utah	1919	6	3,000	F	F	F	F	F	P	F	F	F	F	F	F	F	F
Vermont	1925	2	650	F	F	P	F	F	N	N	F	F	F	F	F	P	F
Virginia	1920	10	3,050	F	F	P	F	F	F	F	F	F	F	P	F	F	F
Washington	1921	3	3,000	F	F	P	F	F	F	F	F	F	F	F	F	P	F
West Virginia	1919	9	3,500	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Wisconsin	1925	10	5,000	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Wyoming	1919	3	980	P	F	P	F	F	F	N	F	F	N	F	F	P	N	F

Note: Alabama and Mississippi use commercial laboratories; Colorado, commercial and university laboratories.

10½—Arizona and Wyoming. 10—California. 9½—Maryland and Rhode Island. 8½—Delaware. 6½—North Dakota. 6—Montana. 4—South Dakota.

In some cases full equipment would be superfluous. For example, tests for sand-clay roads are unnecessary in Massachusetts, New York and Pennsylvania.

Comparing the several classes of tests on the basis of the number of state laboratories equipped for them, we find all laboratories fully equipped for only cement and sand. All are either fully or partially equipped for testing gravel and rock also. Scoring the several classes of tests, counting partial equipment as one-half, we find as follows: 45—Cement and sand. 43—Gravel. 42½—Concrete and rock 40—Steel. 39—Bituminous mixtures. 38—Bituminous materials. 37—Slag. 34½—Corrugated metal culverts and sand-clay. 32—Drain tile and paint. 31½—Concrete, etc., culverts. 26—Paving brick.

Algae in Water Supplies*

Kinds of algae found in water supplies, their characteristics, and method of preventing or controling their growth.

By N. L. Huff†

The algae of our water supplies are minute forms of plant life, often too small to be seen with the naked eye. In structure they rank among the simplest of plants, yet in their conquest of the earth they have been preeminently successful. They are found in lakes and rivers, ditches, ponds, reservoirs, in fact wherever natural waters are exposed to the light. In the economy of nature they play an important role for they are the ultimate source of food for practically all of our fish and other animal life of pond and stream. In small lakes and reservoirs, however, there is often an over-production, they form offensive accumulations and many even become a menace to public health.

In large and deep lakes where the temperature is low, the water may be almost of crystal clearness, yet a plankton net drawn through the water or a fine sand filter will separate out countless millions of these minute organisms. But it is in shallow lakes and sluggish streams, where the water reaches a high summer temperature, that they find conditions most favorable for their growth and development and form massive scums and ill-smelling slimes.

When present in small numbers, algae are not injurious to health nor are they particularly objectionable. If abundant, however, they not only become displeasing to the eye, but certain forms produce offensive tastes and odors that render the water unfit for domestic use.

Attempts to classify tastes and odors caused by algae have not been very successful. Such terms as musty, aromatic, woody, and grassy are often used but are rather vague and not therefore very satisfactory. In some cases living algae have a characteristic odor especially when present in great quantities.

Algae most troublesome in water supplies fall naturally into two large groups, the green algae (Chlorophyceae), and the blue-green algae (Cyanophyceae). The first of these groups, which is the less objectionable of the two, for our purpose may again be divided into three groups. One of these consists of unicellular and colonial forms of bright green color, usually free-floating, drifting with the water currents but remaining within a few feet of the surface. Members of this group often impart a greenish color to the water, but they seldom form scums and are not often present in sufficient quantities to be highly objectionable.

The second group of green algae, including the filamentous forms, do not ordinarily produce odors, but they accumulate in filthy-looking masses forming scums that are unattractive to say the least. Some of these have attachment organs by means of which they cling to stones or submerged water-weeds and so long as they remain completely submerged are not highly objectionable. Often however they form tangled masses which break loose from their moorings and come to the surface where they continue to thrive for the rest of the summer. Other forms have no attachment organs and from the beginning are free to form objectionable surface scums.

As a result of certain life processes, green plants give off oxygen when growing in the sunlight. In submerged filamentous green algae this gas often collects in the meshes among the filaments until the whole mass is buoyed up to the surface forming the familiar scums. If no pond-weeds or other plants are present to support the mass at the surface it may settle to the bottom at night or when the oxygen in the meshes among the threads has escaped. But the light of another day will generate more oxygen, and again the mass will rise to the surface. Sooner or later the raft-like mass, drifting hither and thither with winds and waves, may find anchorage among the stems of pond-weeds or bulrushes and here it may continue to thrive as a pond-scum for the remainder of the season. Algae of this type are comparatively long-lived, a given individual may persist for the entire season. They are practically odorless and even at the end of the season when they die and disintegrate the process is a slow, gradual one and is not accompanied by disagreeable odors as in case of the blue-green algae. From the aesthetic point of view however they are highly objectionable, and should be eliminated early in the season or whenever they begin to form conspicuous scums on the surface.

The third group of green algae troublesome in water supplies is that very large and widely distributed group known as diatoms. They are unicellular forms, often held together loosely in colonies, sometimes attached to water-weeds, stones or other submerged objects, but the most troublesome forms are free-floating. The specific

*Paper before the Minnesota Section, American Water Works Association, somewhat condensed.

†Assistant Professor of Botany, University of Minnesota.

density of diatoms is nearly the same as that of water and they seldom form scums, but during the summer months may be evenly distributed through that stratum of water which is agitated by winds and waves. In our small lakes this means that they are commonly distributed to a depth of about 20 feet. Below this depth the water is stagnant during the summer and diatoms in this stagnant water are rare or absent. Unlike many of the scum-forming algae that thrive only during the warmer seasons, some diatoms are far more abundant in the cool waters of spring and autumn than during mid-summer.

The green coloring matter of diatoms is commonly obscured by a brown pigment so that when abundant they impart to the water a muddy brownish color. Under conditions most favorable for their development the water may become so turbid that light-colored objects become invisible a few inches below the surface, and the fishy odor characteristic of diatoms may become quite offensive. Not only is such water unsuitable for ordinary domestic use, but on account of strains produced it is unfit for use in laundries or for the manufacturing of paper.

The algae most detested as contaminators of public water supplies belong to that universally distributed group, the blue-green algae. They are minute plants of very low organization, often single cells existing alone. Others form long chains or threads, still others form colonies with thousands of individuals held together by a watery gelatinous matrix. Some of the filamentous forms cling to the mud or stones in the bottom, but most of the colonial forms are free-floating and being lighter than the water tend to form scums on the surface.

The method of reproduction in these unicellular forms consists in a simple cell division, so that each division results in doubling the number of plants. The total number of individuals is doubled or trebled every twenty-four hours, and this rate of increase may continue for several weeks during the summer, giving more than a billion offspring from a single individual in a month!

The cells of these blue-green aglae are exceedingly delicate and fragile. Even when living and growing some of these forms are known to emit a disagreeable odor fittingly described as a "pigpen" odor, but with death and disintegration the odors are intensified and become exceedingly offensive. When abundant they produce scums like green paint or Paris green and with favorable winds their odors may be detected a half mile or more from the lake.

To prevent or control the growth and development of these objectionable organisms in our small lakes and reservoirs, the most effective method known at the present time consists in the application of copper sulphate in quantities sufficient to destroy the algae, but not large enough to prove objectionable from the standpoint of the consumer. The method of distributing the copper sulphate in lakes and reservoirs by dissolving the crystals out from coarse sacks towed behind boats is quite satisfactory and is too well known to need further description here. There are cases, however, where the trouble is caused by definite scums where spraying is a more effective method of treatment.

In regard to the amount of copper sulphate necessary to keep a reservoir free from algae, no rule can be given. The various species of algae are not equally sensitive to copper, in fact some species are very resistant to its effects. Even for a given organism the quantity necessary for its destruction is affected by the water temperature, the amount of organic matter dissolved or suspended in the water, the hardness of the water, and several other conditions. A knowledge of the nature and life-habits of the organisms causing trouble is essential if one would use copper sulphate most effectively.

The unicellular green algae are not as troublesome as some others, but occasionally they become sufficiently abundant to impart a greenish color to the water. They vary greatly in form and size. Most of them reproduce by division of the cell into two, but some of them form complete little colonies within the parent cell. Some reproduce sexually and form heavy-walled resistant resting spores. The Desmids are of varied and artistic design, usually constricted between the two half-cells. They occasionally form resting spores but more commonly form new individuals by division of the old cell into two. Copper sulphate is most effective if applied during the period of great vegetative activity. The resting spores are probably not affected by small quantities of copper sulphate that prove fatal to the actively growing cells.

Pediastrum is sometimes very abundant in shallow lakes with muddy bottoms. It consists of a colony of individuals arranged in a beautiful design, radially symmetrical. Each individual is independent of the others and may form within itself an entire colony of new individuals.

The water-net (Hydrodictyon) consists of cylindrical thread-like segments connected up to form a lace-like net, often several inches in length. These nets, while very beautiful when viewed with a lens or microscope, float on the surface in great tangled masses and form unsightly scums where conditions are favorable for their growth. They reproduce by forming an entire new net within each segment of the old net, or by a sexual process which results in the formation of a resistant resting cell or spore-like body that carries the plant over winter. When the water-net is free-floating it is very sensitive to copper sulphate; when lying on the mud of the bottom it seems to be very resistant. The probable explanation for this lies in the fact that the abundant organic matter in solution or in suspension near the bottom consumes the copper before it actually reaches the living cell.

Cladophora is one of the most common of our scum-forming green algae. It consists of rather coarse, profusely branched threads and is often attached to some submerged object. The green mossy growth seen in running streams and under water-falls is often due to this plant. In lakes and ponds it often breaks away from the substratum and forms great raft-like masses that float about the surface or lodge among pondweeds near the shore. This form is very resist-

ant to copper sulphate, requiring ten times as much of the chemical for its destruction as do many other forms. Fortunately it is most objectionable when it floats on the surface and forms scums, and in this condition it can be destroyed by spraying the surface of the water with a strong solution of copper sulphate. Since the scum at the surface receives the full effect of the spray, this resistant form may be destroyed while more sensitive species at greater depths may escape injury.

Perhaps the most common of all our scum-forming green algae is Spirogyra. It consists of long, unbranched, silky threads, soft and slimy. Under the microscope we see its cylindrical cells arranged end to end, each with one or more green ribbon-like bands wound spirally within the delicate transparent wall. The reproduction in this plant is usually sexual, the male and female gametes from different cells uniting to form a heavy-walled resistant spore which carries the plant over winter. Spirogyra is one of the most sensitive of our algae to copper sulphate, one part in ten million being sufficient to destroy most of our common species. To be most effective the copper sulphate should be applied during the growing period preceding reproduction. The resting spores are not affected by ordinary copper sulphate treatment of the water.

Pond-felt (Vaucheria) is more commonly found growing in the bottom of ponds and springs, in shallow water. Its filaments are branched, but not segmented. Its common method of multiplication is by means of motile, non-resistant, spore-like bodies, but at certain seasons it too forms the resistant resting-spore to carry the plant over winter.

The diatoms constitute an interesting group of organisms. Each individual is one-celled and is enclosed in a transparent, siliceous, glass-like wall consisting of two valves one overlapping the other like a pill-box and cover. The valves are marked or sculptured with numerous regular transverse lines. Some species grow on stalks, attached, others solitary or in colonies. In form they vary greatly, rods, cylinders, disks, wedges, or boat-shaped, but all are of definite geometrical design. During the summer months when the water temperature is high (60° to 80° F.) these may respond quickly to copper sulphate treatment, but during the spring and autumn overturning, when the water temperature is low and great quantities of dissolved or suspended organic matter are present in the water, they are but little affected by heavy treatments of copper sulphate. They may normally disappear soon after the period of circulation has passed and it is doubtful if a moderate quantity of copper sulphate will hasten their disappearance at this time.

The blue-green algae are very common and are most fragile and most objectionable of all our water-supply algae. A drop of water taken from near the surface of lake or pond may, under the microscope, show thousands of individuals representing many different species.

Clathrocystis consists of single cells held together loosely in colonies by a gelatinous matrix. Reproduction consists in simple cell division, and the rate of increase is very rapid in warm weather when conditions are favorable. Heavy-walled resistant spores are not formed so far as known, and elimination of this species with copper sulphate is comparatively easy.

In Oscillatoria the disk-like cells form threads the ends of which commonly oscillate through a small arc when the plants are actively growing. In Lyngbya the cells are disk-like but a heavy sheath is present and movement is lacking. Both of these forms are more commonly found in the bottom in shallow water, and they thrive best in the presence of sewage or decaying organic matter, but occasionally cause trouble in public water-supplies. They do not produce heavy-walled spores and are responsive to moderate quantities of copper sulphate.

Anabaena, one of our most troublesome water-supply algae, is represented by several common species. Its cells are joined in chains like chains of beads. Its increase during the summer is due to a rather rapid division of its cells and threads, but it forms heavy-walled resting spores for carrying the plant over winter. It is one of the most sensitive of algae to copper sulphate, but for best results it should be destroyed before the spores are formed.

Aphanizomenon sometimes becomes very abundant in certain lakes, but is less common than Anabaena and Clathrocystis. Its filaments are arranged in loose bundles but with little agitation of the water these bundles are broken up. It has less of a tendency to form scums than other troublesome forms but gives a blue-green color and a turbidity to the water. It is carried over winter by heavy-walled resting spores.

In Rivularia we have a tapering thread resembling a whip-cord in form. The resting cell is formed near the basal end. This form grows in colonies that float near the surface and is commonly found along with Anabaena and Clathrocystis.

All of the blue-green algae which cause trouble in our water supplies are sensitive to copper sulphate and disappear within three or four days after treatment. The disappearance of course is due to the complete disintegration of the plants, and since decay of organic matter is usually accompanied by the liberation of gases, and the gases here liberated are ill-smelling, best results are obtained by treating as soon as they have begun their rapid multiplication, and before heavy scums have been formed. The destruction of small numbers of algae, even such forms as Anabaena and Clathrocystis is not accompanied by odors that can be readily detected, and if the treatment is made at the proper time there should be no ill after-effects. It is the delayed treatment that is followed by objectionable features. In case of spore-forming species the best results are obtained by treating before the spores have been formd, since resistant spores may not be affected by the copper sulphate that would destroy active plants.

In all cases where troubles frequently arise from algae, microscopic examination of the water should be made daily by one who understands the organisms and their habits of life. Any tendency on the part of troublesome forms such as Spirogyra, Anabaena, and Clathrocystis, to increase rapidly should be checked at once by the proper application of copper sulphate. If this is done there can be no serious after-effects of odors and tastes due to accumulated masses of objectionable algae.

Precast Concrete Curb in City Streets

Precast concrete curbs, factory made, manufactured and cured much in the manner of other concrete units and under just as stringent specifications, are being used in a number of cities, including New Orleans in the south, and Lackawanna, Tonawanda, Buffalo and other western New York state cities in the east.

Figure 2 shows the type of precast curb in use in Buffalo. In this, the heights is 17 inches, the width is 5 inches, and the length varies from 1 foot 7 inches to 4 feet. The same width carries through from the bottom to the top of the curb, there being no batter. When so desired or specified, the upper corner of the curb facing the pavement is reinforced with a galvanized steel curb guard to take the wear from friction and bumps.

Figure 3 shows the type of precast curb in use in Lackawanna and Tonawanda. This differs from the Buffalo type chiefly in that it employs a batter. It is 18 inches in height, 6 inches wide at the bottom and 5 inches at the top, the batter occurring in the upper eight inches which constitutes the exposed portion of the curb. Like the curb shown in Figure 2, this type can be made with a galvanized steel curb guard for use where traffic is heavy.

While the steel nose is used sucfully in both the foregoing types, there has been some objection to its use by some engineers while other engineers favor it. When the nosing can be left off, it brings a lower manufacturing cost which makes the curbing more attractive to cities using them.

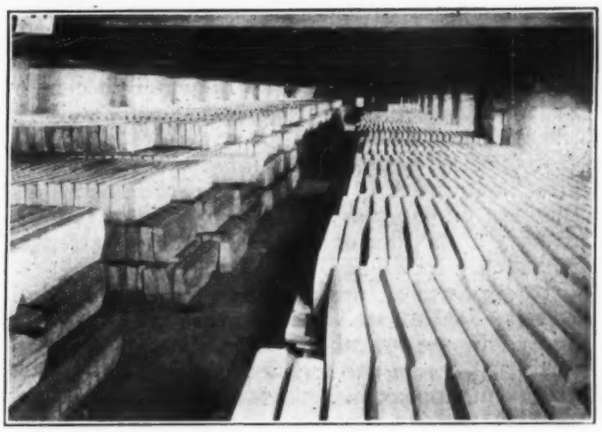


FIG. 1—PRECAST CURB PLANT OF BUFFALO WASH TRAY CO.

Figure 4 shows the type of curb that is built without a steel nose. It is exactly like the one in Figure 3 except that it has a 2-inch batter starting in the upper 8 inches. The greater slope and rounded top does away with the necessity of the steel guard, for its shape prevents cracking under impact, tending more to slide the wheels of the vehicles up onto the curb than to serve as an impact breaker.

Most plants manufacturing precast curbing use a 1:2:3 mix for the concrete. Cement of standard specifications and torpedo sand (grits) and gravel are used. The coarse aggregate runs from ¾-inch to 1-inch in size. The consistency of the mix is just wet enough to allow the concrete to fill the form with rodding.

Precast curbs have several advantages, the most important of which, perhaps, is quality. In the factory-made curb, the section is cast upside down in a mold and the mix is rodded

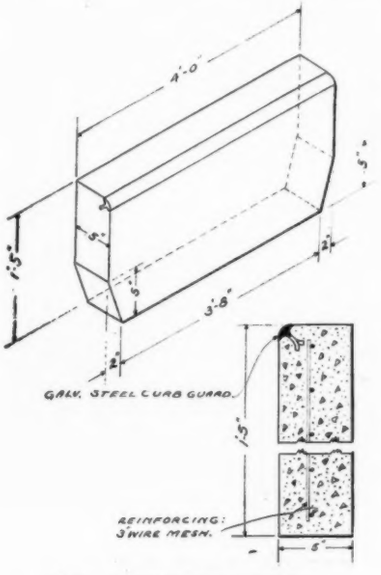


FIG. 2—BUFFALO CURB

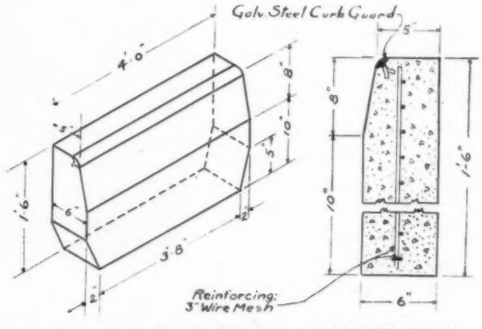


FIG. 3—LACKAWANNA AND TONAWANDA

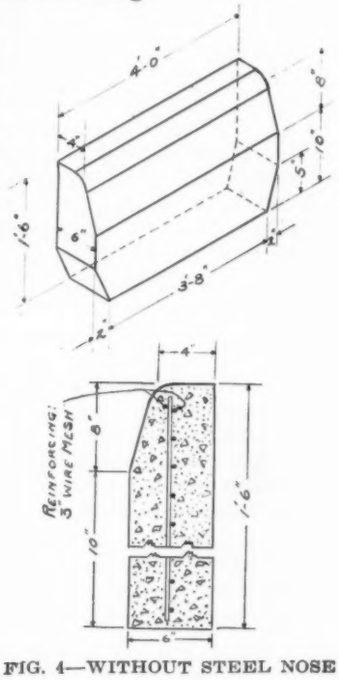


FIG. 4—WITHOUT STEEL NOSE

or spaded into a dense, uniform mass. Being made in a plant especially equipped for concrete-making, there is constant supervision over the materials, the mix, the ratio of water to cement and the grading of aggregates to insure uniform strength and density of the concrete. The precast curb is steam cured for at least ten days after manufacture and none are shipped until they are 30 days old. All such curbing is made to have a 3000 lb. or more compressive strength per square inch.

In appearance, precast units have a high uniformity for all are cast in identical molds and every curve, line and corner corresponds with every other and the finished curbing has a neat, clean cut appearance.

Tests of Oil for Desert Sand Treatment*

To determine best oil for use for slope and shoulder protection of highway across sand hills of Imperial County, California.

By C. L. McKesson, Materials and Research Engineer

From the highway engineer's viewpoint it sometimes appears that all agencies are combined in an effort to destroy the highway which he has striven to make permanent.

Overloaded vehicles do their part but natural forces are even more active. Swelling and unstable soils, alkali, extreme temperature changes, floods and wave action along the coast are some of the better known destructive agencies. In some localities the wind joins other natural forces in the attack on the highways. In fact wind alone, if given free scope, would soon efface some of the highways.

The sand hills section in Imperial County, in California, is one on which highway engineers have battled the wind ever since highway construction began in that section. Since the construction of the temporary plank road across these dunes, each heavy wind storm has buried long stretches of the highway beneath deep sand drifts in some ways not unlike the snow drifts of other regions. Thousands of dollars have been expended in removing the sand only to have it replaced by the next storm.

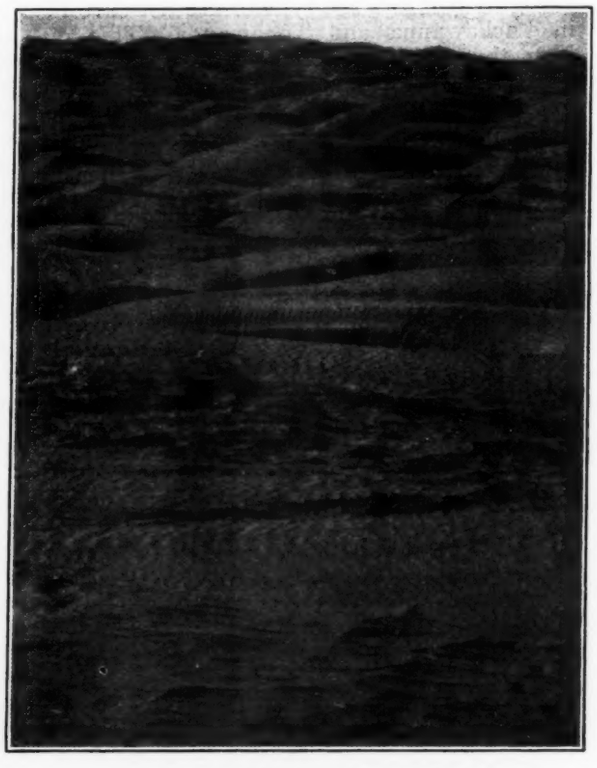
The Oregon highway department has waged a similar battle with drifting sands along the Columbia river east of The Dalles, and in a single wind storm has lost long stretches of newly graded highway. Before the advent of the Columbia river highway the railroad has been for years engaged in a struggle against the drifting sands, and perhaps it is to its engineers that we are indebted for the initiation of the practice of oiling as a protection against wind action. The Oregon Highway Department after a few rather disastrous experiences adopted oil protection, to the extent of oiling large areas on the windward side of the highways as well as the highway right of way and the slopes. The work done by them and the equipment used was described by A. F. Morris, in "Public Roads," for August 1920.

In planning the new highway across the sand hills section, engineers of the California Highway Commission responsible for design and construction decided to utilize oil for slope and shoulder protection, and the Testing and Research Department was asked to make tests to determine character of oil suitable for the work and the amount required.

Rather simple tests were made which, it is believed, indicate service values. These tests will be described for the benefit of those interested in the problem of drifting sands or wind erosion.

In making the tests various oils were used with asphalt contents up to about 65 per cent. The experiments have demonstrated that the oil best suited for the work should contain 40 to 50 per cent of asphalt. Oil of this kind can be applied without heating and will penetrate readily. There is a sufficient asphalt content to give good body and to hold sand particles together in a heavy flexible mat after the more volatile oils have evaporated.

A large sample of the desert sand for test purposes was obtained from Division Engineer E. Q. Sullivan. The sand was placed in pans hav-



IMPERIAL COUNTY SAND HILLS
A close-up of a section of the six miles of dunes across which a pavement is now being placed. Shoulders and slopes will be oiled to prevent erosion by winds.

*From "California Highways," bulletin of the California Highway Commission.

ing an area of one square foot and the oil applied in a finely divided spray under an air pressure of 50 pounds. Repeated trials indicated that one-half gallon per square yard was the least amount that would entirely cover the sand. The lighter oils were applied cold and the heavier oils were heated. After the application of oil, the resulting oil cake was cut in small squares and the average thickness measured. The values given in the following table are averages of a number of samples.

Penetration of desert sand with various asphaltic oils

Kind of Oil	Sp. Gr. Be	Amt. per Sq. Yd. Gal.	Penetration Cold Sand	Penetration 150° F. 1 Wk.	Remarks
43% Asphalt	18.2°	½	¼	¾	Applied at
		¾	⅝	1¼	about 75° F.
		1	⅞	1½	
Fuel Oil	17.2°	½	½	¾	Applied at
		¾	⅝	⅞	about 75° F.
		1	¾	1⅛	
50% Asphalt Road Oil	16.8°	½	¼	½	Applied at
		¾	¾	1¼	about 75° F.
		1	1¼	1¾	
62% Asphalt Road Oil	15.2°	½	¼	¾	Applied at
		¾	½	¾	150°-175° F.
		1	¾	1¼	
65% Asphalt Road Oil	13.7°	½	½	¾	Applied at
		¾	¾	1	150°-175° F.
		1	1	1⅜	

After measuring the penetration of oil in the cold sand the pans containing the sand were placed in an oven and maintained at a temperature of 150 degrees F. for one week and the depth of penetration again determined. This was done to determine maximum probable penetration which will be obtained in the summer time under desert heat conditions.

A Diesel oil was also tested but it lacked "body" and did not produce a good oil mat on the sand.

All of the oils gave good mats of oil and sand but the lighter oils gave good penetration without heating and were therefore recommended for use.

Oiling as above described gives protection against drifting sand when adjacent dunes and sandy areas are oiled and is also useful in preventing erosion of sand fills by wind and water.

Steel Traffic Treads

An experiment with AW steel traffic plates has been under way in California since February, when treads were installed on the Jordan Creek bridge, a wooden structure on the Redwood highway about five miles south of Scotia, Humboldt County. When the plates had been in service for a period of approximately four months Division Engineer T. A. Bedford said:

"Four lines of traffic treads, 20 inches wide and ⅜ inch thick, were installed on the Jordan Creek bridge, 140 feet in length, as a protection to the wooden floor.

"Approaches to this bridge are on curves and the plates are laid on tangents. As a result, machines run off the plates at each end and in the middle for the reason that, in a length of 140 feet, drivers do not notice the treads until they are nearly across the bridge.

Observations would indicate that, for best results, installation of traffic treads should not be made on bridges of less than 200 feet in length; more particularly if the roadway at the approaches is on a curve.

There is reason to believe that on long bridges drivers will follow the plates and that the life of wooden floors will thereby be materially increased. Better results will be obtained if plates with a width of 24 to 30 inches are used instead of the 20-inch size installed at Jordan Creek. The wider plates will be worth the difference in cost because of the greater ease with which they can be followed by traffic.

Sewerage Statistics

Length of each kind of sewer laid in each city last year and total lengths at end of year. Information concerning methods and costs of flushing and cleaning sewers. Methods of ventilating sewers.

Twenty years ago the Sanitary Section of the Boston Society of Civil Engineers adopted a form for sewerage statistics with a view to its use by cities generally, thus permitting more ready use and comparison of such statistics and less error in interpreting them. The form was prepared by a sub-committee of which Harrison P. Eddy was chairman.

At least twenty-five or thirty cities used this form for a few years; but there was not then a general appreciation among municipal sewerage officials of the importance of such information, and the use of the form has been continued by only a few. The past few years have seen considerable increase in interest in sewerage engineering and it seems to us probable that a renewed attempt to secure the general use of a good standard form would meet with more success.

The Boston form would probably need some revising to bring it up to date, but in the absence of any better we have used part of it as a basis

(Continued on page 263)

Sanitary Sewers

Length (in feet or miles, and not including house connections) constructed in 1925 and in use at end of year.

City	Vitrified Pipe: Laid in 1925	Vitrified Pipe: Tot. at end of year	Cement Pipe: Laid in 1925	Cement Pipe: Tot. at end of year	Other Kinds: Kind	Other Kinds: Laid in 1925	Other Kinds: Tot. at end of yr.	Manholes: Built in 1925	Manholes: Total at end of yr.
Alabama:									
Birmingham ..	.....	.....	.....	.....	Concrete in place	25.5	349.2	110	.....
Florence	20,000	200,000	.....	.....		.....	.....	65	650
Huntsville	2,400	.....	.....	.....		.....	.....	8	.....
Arizona:									
Bisbee	.....	83,950	.....	.....	Cast iron Wood	....	12,750 3,300	.....	150
Arkansas:									
Fayetteville ..	4.0	19.0	.....	.....	.....	.....	.....	52	.....
California:	..								
Berkeley	7,089	200	.....	.....	.....	.....	.....	30	.....
San Rafael....	8,264	.....	.....	.....	.....	.....	.....	20	.....
Colorado:									
Boulder	800	.....	.....	.....	.....	.....	.....	.....	725
Col. Springs..	0.5963	88.684	.....	.....	.....	.....	.....	17	1,150
Connecticut.									
Ansonia	1,070	22.0	.....	.....	Brick	.....	2.0	.....	.....
New Britain..	3.1931	.....	.....	.....	.....	.....	.....	.....	.....
Florida:									
Fernandina ...	.....	34,400	.....	.....	.....	.....	.....	.....	57
Tallahassee	5,000	110,750	.....	.....	.....	.....	.....	18	280
Georgia:									
Americus	500	.....	.....	.....	.....	.....	.....	2	.....
Brunswick ...	.....	8.0	.....	1.0	Cast iron	.....	2.0	.....	200
Le Grange.....	.....	36.0	.....	.....	.....	.....	.....	.....	476
Macon	16.0	100.0	.....	.....	.....	.....	.....	200	1,500
Marietta	.....	.....	3,000	.....	.....	.....	.....	8	.....
Illinois:									
Canton	2.5	29.55	.....	.....	.....	.....	.....	.....	.....
Carbondale ...	14,600	.....	.....	.....	.....	.....	.....	25	.....
Kewanee	.....	20.0	.....	.....	.....	.....	.....	.....	200
Macomb	3,510	.....	.....	.....	.....	.....	.....	9	.....
Indiana:									
Lebanon	2,500	13.0	.....	.....	.....	.....	.....	.....	200
Iowa:									
Charles City..	2,630	105,770	.....	.....	.....	.....	.....	7	.....
Davenport	924	573,617	.....	.....	Concrete in place Brick Segment block Other kinds	....	208 19,654 27,892 5,154		
Fort Dodge..	3.0	45.23	.....	.....	.....	.....	.....	.....	.....
Keokuk	366	.....	.....	.....	.....	.....	.....	1	.....
Red Oak.....	1,500	18.0	.....	.....	.....	.....	.....	5	161
Kansas:									
Lawrence	2,810	162,000	.....	.....	.....	.....	.....	.....	.....
Newton	19,555	.....	.....	.....	Cast iron	180	.....	52	.....
Wichita	33,918	.....	.....	.....	.....	.....	.....	175	.....
Kentucky.									
Ashland	1,006	223,111	.....	.....	.....	.....	.....	5	632
Louisville	4.25	6.25	.....	.....	Segment block	2.0	.....	570	.....
Maryland:									
Baltimore	347,737	.....	.....	.....	Brick & concrete	2,106	.....	1,161	.....
Massachusetts:									
Andover	677	.....	.....	.....	Concrete in place	774	.....	.....	.....
Brockton	4,780	.....	.....	.....	.....	.....	.....	16	1,264
Brookline	1,771	415,653	.....	.....	.....	.....	.....	14	.....
Fall River ...	5,783	.....	.....	.....	.....	.....	.....	51	.....
Haverhill	1,453	13.8	.....	.....	.....	.....	.....	7	294
Melrose	11,746	241,104	.....	.....	Brick	.....	3,174	60 ft.	.....
North Adams	1,600	149,514	.....	.....	.....	.....	.....	.....	.....
Stoneham	2,000	.....	.....	.....	.....	.....	.....	10	.....
Waltham	6,063	50.40	.....	.....	.....	.....	.....	32	1,129
Watertown ..	11,565	.....	.....	.....	.....	.....	.....	.....	.....
Wellesley	16,265	110,081	.....	.....	Cast iron	16,951	.....	65	510
Michigan:									
Hastings	3,000	.....	.....	.....	.....	.....	.....	12	.....
Muskegon Hgts	4,200	15	.....	.....	.....	.....	.....	.....	.....
Owosso	15,312	167,000	.....	.....	.....	.....	.....	45	.....
Pontiac	5.000	.....	.....	.....	Brick	1,800	.....	200	.....
Sturgis	6,020	.....	.....	.....	.....	.....	.....	22	.....
Minnesota:									
Faribault	4,513	111,180	.....	.....	.....	.....	.....	.....	.....
New Ulm ...	860	3,860	.....	.....	Segment block	.....	1,720	.....	222
Owatonna	833	3,046	.....	.....	.....	.....	.....	13	.....
Virginia:	.....	6	.....	6	Segment block	.....	6	.....	.....
Mississippi:									
Hattiesburg ..	2,000	100,000	.....	.....	.....	.....	.....	50	.....
Missouri.									
Joplin	.....	257,221	12,324	145,984	.....	.....	.....	.....	.....
Kirksville	25,000	25,000	.....	.....	.....	.....	.....	150 ft.	.....
St. Louis	.....	.....	.....	.....	.....	.....	.....	351	.....
Montana:									
Billings	.....	213,943	.....	.....	.....	.....	.....	.....	431
Nebraska:									
York	.....	10	.....	.....	.....	.....	.....	.....	110
New Jersey:									
Newark	2.18	88.72	2.02	3.84	Brick Other kinds	....	5.38 1.26	.....	.....
Nutley	17.730	.....	.....	.....	.....	.....	.....	101	.....
So. Orange	1,600	17	5,000	17	.....	.....	.....	.....	.....
Westfield	.28	45.55	.....	.....	.....	.....	.....	.....	.....

City	Vitrified Pipe: Laid in 1925	Vitrified Pipe: Tot. at end of year	Cement Pipe: Laid in 1925	Cement Pipe: Tot. at end of year	Other Kinds: Kind	Other Kinds: Laid in 1925	Other Kinds: Tot. at end of yr.	Manholes: Built in 1925	Manholes: Total at end of yr.
New York:									
Auburn	2,889	.....	.....	.....	.....	.....	.....	7	.....
Endicott	165	.....	.....	.....	.....	.....	.....	.....	.....
Geneva	3,000	31	.....	.....	.....	.....	.....	5	300
Gloversville	2,056	2,056	.....	.....	.....	.....	.....	13	.....
Troy	2,065	.....	.....	.....	.....	.....	.....	.....	.....
North Carolina:									
Greensboro	21.2	126	.....	.....	.....	.....	.....	451	2,026
Thomasville	600	20	.....	.....	.....	.....	.....	2	211
Wilmington	2,500	.....	2,750	2,750	.....	.....	.....	.....	.....
Wilson	2	50	.....	.....	.....	.....	.....	50	.....
North Dakota:									
Jamestown	2,600	14	.....	.....	.....	.....	.....	.....	.....
Ohio.									
Cambridge	0.5	26	.....	.....	.....	.....	.....	7	.....
Columbus	112,000	112,000	.....	.....	.....	.....	.....	.....	727
Cuyahoga Falls	1.5	.....	.....	.....	.....	.....	.....	30	.....
E. Cleveland	130	153,229	.....	.....	.....	.....	.....	.....	1,391
Lancaster	.52	3.8	.....	.....	.....	.....	.....	.....	.....
New Boston	.....	5	.....	.....	.....	.....	.....	.....	90
Troy	0.5	12	.....	.....	.....	.....	.....	.....	.....
Zanesville	14.78	21.8	.....	.....	.....	.....	.....	345	456
Oklahoma:									
Ponca City	7,000	.....	.....	.....	.....	.....	.....	15	.....
Tulsa	50.22	.....	.....	.....	Cast iron	0.43	.....	471	.....
Oregon:									
Salem	.....	.....	60,000	.....	.....	.....	.....	200	.....
Pennsylvania:									
Allentown	4,918	91,955	.....	.....	.....	.....	.....	13	375
Connellsville	1,015	12,000*	.....	.....	.....	.....	.....	.....	.....
Franklin	200	.....	.....	.....	.....	.....	.....	.....	.....
Hazleton	7,093	41,236	.....	1,876	.....	.....	.....	.....	.....
Lansford	520	520	.....	.....	.....	.....	.....	4	4
Lebanon	1,244	129,266	.....	9,418	.....	.....	.....	.....	.....
Mahanoy City	525	.....	.....	.....	.....	.....	.....	3	.....
New Brighton	500	12	.....	.....	.....	.....	.....	.....	.....
Norristown	4,600	4,600	.....	.....	.....	.....	.....	28	28
Oil City	170	254,019	.....	4,186	Brick	.....	4,700	.....	.....
					Segment block	.....	158		
Sharon	2,935	.....	.....	.....	.....	.....	.....	.....	.....
Steelton	1,000	1,000	.....	.....	.....	.....	.....	.....	.....
Tyrone	3,000	21,500	.....	.....	.....	.....	.....	11	55
Warren	5,500	32	.....	.....	.....	.....	.....	15	.....
Wilkinsburg	2.06	46	.....	.....	.....	.....	.....	34	.....
Rhode Island:									
Pawtucket	0.97	.....	.....	.....	.....	.....	.....	.....	.....
Westerly	14,332	15.07	.....	.....	.....	.....	.....	60	247
So. Carolina:									
Charleston	10	57	.....	.....	.....	.....	.....	200	933
Greenville	8,000	353,129	540	540	.....	.....	.....	43	1,275
Greenwood	1,200	1,200	2,600	2,600	Brick	8,000	.....	16	.....
Orangburg	800	.....	.....	.....	.....	.....	.....	.....	.....
Tennessee:									
Dyersburg	5,000	5,000	.....	.....	.....	.....	.....	.....	.....
Texas.									
Brownwood	7,530	.....	.....	.....	.....	.....	.....	.....	.....
Paris	20,761	211,000	.....	.....	.....			21	.....
Utah:									
Salt Lake City	30,087	1,407,830	.....	209,973	Brick	.....	18,000	79	4,441
					Other kinds	.....	68,109		
Virginia:									
Charlottesville	2	30	.....	.....	.....	.....	.....	25	500
Fredericksb'g	722	15	.....	.....	.....	.....	.....	2	190
Staunton	3,705	9.5	.....	.....	.....	.....	.....	6	50
Suffolk	7,182	7,182	.....	.....	.....	.....	.....	18	18
Wisconsin:									
Manitowac	5,900	40	.....	.....	.....	.....	.....	20	600
Oshkosh	.....	.....	4,200	.....	.....	.....	.....	.....	.....
Waukesha	1.890	38	.....	.....	.....	.....	.....	.....	.....
Wyoming:									
Cheyenne	5,176	5,176	.....	.....	.....	.....	.....	12	12

*Includes both sanitary and storm sewers.

Inverted siphons: These were reported as follows: Brockton, Mass., none built in 1925, 4 total. Waltham, Mass., none built in 1925, 6 total. York, Neb., none built in 1925, 25 total. Greensboro, N. C., none built in 1925, 7 total. Ponca City, Okla., 7 built in 1925. Lebanon, Pa., none built in 1925, 5 total. Sharon, Pa., 2 built in 1925, 2 total. Charleston, S. C., none built in 1925, 5 total. Salt Lake City, Utah, 1 built in 1925, 1 total. Fredericksburg, Va., none built in 1925, 2 total.

(*Continued from page 261*)

for the sewerage questionnaire sent by us to city engineers last month, including the first sixteen of about one hundred items. The information so obtained has been compiled in the tables published in this issue.

The questions asked were as follows:

Length (given in feet or miles and not including catch-basin or house connections) of sewers laid during 1925 and those in use at the end of that year, classified as "For sanitary sewage only," "For sanitary sewage and surface water," and "For surface water only"; also as to whether constructed of brick, concrete poured in place, segment block, vitrified pipe, cement pipe, or other material.

Number of inverted siphons in each class of sewer.

Number of manholes in each class of sewer.

What method of flushing sewers do you employ? How many automatic flushtanks? How often do they flush? How many direct connections with water mains for flushing? Number of flushings of entire system during year? Cost of flushing per mile for labor, water and materials?

What is your method of cleaning? Cost of cleaning per mile for labor, materials and appliances? Number of stoppages last year?

Method of ventilating sewers (as through house connections, manhole heads, special vent pipes, etc.)?

Storm Water Sewers

Length (in feet or miles, and not including catch-basin connections) constructed in 1925 and in use at end of year.

City	Brick: Laid in 1925	Brick: Total at end yr.	Concrete (in place): Laid in 1925	Concrete (in place): Total at end yr.	Segment Block: Laid in 1925	Segment Block: Total at end yr.	Vitrified Pipe: Laid in 1925	Vitrified Pipe: Total at end yr.	Cement Pipes: Laid in 1925	Cement Pipes: Total at end yr.	Other Kinds: Kind	Other Kinds: Laid in 1925	Other Kinds: Total at end yr.	Manholes: Built in 1925	Manholes: Total at end yr.
Alabama:															
Birmingham									7.06	88.74				21	
Florence		2,000	5,000	10,000		5,000	8,000	100,000						20	250
Troy							2,100								
California:															
Berkeley			400	3			752	1			Corrugated iron		.5		
San Rafael							1,538		319					5	
Colorado.															
Boulder								10,2*							150
Connecticut:															
Ansonia							978								
Florida:															
Fernandina								1,300							{ Catch basins 10
Georgia:															
Brunswick				5,280				5		4,000	Cast iron		3,000		50
La Grange					700	900									2
Macon			{ 20,000 cu. yd. }				1								
Illinois:															
Kewanee							2	20						50	300
Indiana:															
Lafayette							568								
Lebanon						2,700	1,500	12							50
Iowa:															
Charles City								56,919							
Cherokee								14							125
Davenport				2,477		32,434	475	71,656		616			241		
Fort Dodge					1,100	2,100	.5	28							
Red Oak							118	14,000	300	5,000					
Kansas.															
Wichita											Total of other kinds		71.82		
Kentucky:															
Ashland							17,038	51,622						57	133
Maryland:															
Baltimore	27,588†		17,315				65,421		22,060					619	
Massachusetts:															
Brockton							12,093				Total of all kinds		75.79	26	
Brookline							2,912							10	
Fall River						224	1,964							14	
Haverhill			.5§			.2	6,600	4.7						34	98
Lowell								3.53							
Melrose		659		9,219			1,634	75,612				1,796	1,916	11	387
North Adams							847	52,797				87			
Stoneham							1,500							7	
Waltham							5,782	20.09							
Watertown							3,842								
Wellesley							1,000								
Michigan:															
Alma				6,000		300									
Hastings							2,000							10	
Muskegon Heights						1.5									
Owosso									2,354					8	
Pontiac							3,000							50	
Sturgis					1,560		610				Total of all kinds		10.09	8	
Minnesota:															
Faribault						2,917	526	39,394		2,050					
New Ulm															
Owatonna									3,000	4.41					
Virginia								12.4			Total of all kinds		49,956		
Mississippi:															
Hattiesburg							1,000	8,000	3,000	5,000				20	60
Missouri.															
Kirksville							1,000	1,000							
Montana:															
Billings						1,841	564	59,783		20,351				1	202
Nebraska:															
York				3,480											
New Hampshire:															
Manchester							600	1,800	8,824	14,400				40	70

City	Brick: Laid in 1925	Brick: Total at end yr.	Concrete (in place): Laid in 1925	Concrete (in place): Total at end yr.	Segment Block: Laid in 1925	Segment Block: Total at end yr.	Vitrified Pipe: Laid in 1925	Vitrified Pipe: Total at end yr.	Cement Pipe: Laid in 1925	Cement Pipe: Total at end yr.	Other Kinds: Kind	Other Kinds: Laid in 1925	Other Kinds: Total at end yr.	Manholes: Built in 1925	Manholes: Total at end yr.
New Jersey:															
Newark	.....	2.24	.....	7.56	.....	.....	.4	7.48	1.54	11.33	.....	.....	.08	.....	.....
Nutley	.....	.....	6,950	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	38	.....
So. Orange	.....	.....	.....	.....	.....	.....	.....	.....	7,000	.....	.....	.....	.....	.....	.....
New Mexico:															
Roswell	.....	.....	.....	.....	.....	.....	.....	20	.....	.....	.....	.....	.....	.....	.....
New York:															
Auburn	.....	.....	.....	.....	.....	.....	2,388	.....	.....	.....	.....	.....	.....	10	.....
Elmira	.....	.....	.....	.....	.....	.....	.....	6,024	.....	.....	.....	.....	.....	.....	.....
Endicott	.....	.....	.....	.....	.....	.....	.....	.....	2,474	.....	.....	.....	.....	.....	.....
Geneva	.....	.....	.....	.....	.....	.....	4,000	18	.....	.....	.....	.....	.....	.....	.....
Gloversville	.....	.....	.....	.....	.....	.....	384	384	3,602	3,602	.....	.....	.....	22	22
Herkimer	.....	.....	.....	.....	.....	.....	3,500	.....	850	.....	.....	.....	.....	34	.....
Troy	.....	.....	.....	.....	.....	.....	94	.....	.....	.....	.....	.....	.....	19	.....
North Carolina.															
Greensboro	.....	.....	1,243	2,654	.....	1,560	856	4,879	2,560	3,800	.....	.....	.....	156	284
Thomasville	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	20
Wilmington	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,100	.....	.....	.....	.....	.....
Wilson	.....	.....	.....	.....	100	1,000	.....	.....	.....	.....	.....	.....	.....	.....	.....
North Dakota:															
Jamestown	.....	.....	.....	.....	.....	.....	.....	8	.....	.....	.....	.....	.....	.....	.....
Ohio:															
Columbus	1,267	1,267	.....	.....	17,380	17,380	.....	.....	.....	.....	.....	.....	.....	.....	.....
E. Cleveland	56	6,184	293	1,596	.....	2,497	687	114,141	.....	.....	Stone & cast iron	.....	391	.....	.....
Lancaster	.....	.....	.....	.....	.....	1.1	.....	.....	.....	.....	.....	.....	.....	.....	....
New Boston	.....	.....	.....	.....	.....	.....	.....	3,000	.....	.....	.....	.....	.....	.....	20
Troy	.....	.....	1,200	1,200	.....	.....	.75	Several miles	.....	.....	.....	.....	.....	.....	.....
Wooster	.....	.....	.....	.....	.....	.....	700	6,100	.....	.....	Stone	.....	3,300	.....	.....
Zanesville	.....	.....	.....	.....	.....	.....	.13	6.9	.....	.....	.....	.....	.....	3	145
Oklahoma:															
Ponca City	.....	.....	6,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....
Tulsa	.44	2.59	.81	16	.....	.13	.....	1.71	7.39	74.92	.....	.....	.06	150	.....
Pennsylvania:															
Allentown	.....	40,542	.....	10,868	.....	2,900	7,625	67,839	.....	.....	.....	.....	.....	.....	.....
Connellsville	.....	.....	.....	.....	.....	.....	1,227	.....	.....	.....	.....	.....	.....	.....	.....
Hazleton	.....	.....	.....	.....	.....	.....	6,933	28,789	160	7,765	.....	.....	.....	.....	.....
Lebanon	.....	3,050	.....	2,518	.....	.....	1,100	3,955	.....	11,120	Stone box	.....	1,900	.....	.....
Mahanoy City	.....	.....	.....	.....	.....	.....	429	.....	.....	.....	.....	.....	.....	2	.....
New Brighton	.....	.....	.....	.....	.....	.....	300	2	.....	.....	.....	.....	.....	.....	.....
Morristown	.....	.....	.....	.....	.....	.....	1,350	1,850	.....	.....	.....	.....	.....	.....	6
Oil City	.....	.....	.....	.....	.....	.....	158	.....	.....	.....	.....	.....	.....	.....	.....
Sharon	.....	.....	.....	.....	.....	.....	1,851	.....	.....	.....	.....	.....	.....	.....	.....
Steelton	.....	.....	.....	.....	.....	.....	500	500	.....	.....	.....	.....	.....	.....	.....
Tyrone	.....	.....	.....	.....	.....	.....	900	3,000	.....	.....	.....	.....	.....	.....	.....
Warren	.....	.....	.....	.....	.....	.....	800	.....	.....	.....	.....	.....	.....	.....	.....
Wilkinsburg	.2	.....	.....	.....	.....	.....	.3	10	.....	.....	.....	.....	.....	.....	.....
Rhode Island:															
Providence	0.212	15.974	....	.....	.....	.....	0.769	7.339	.....	.....	.....	.....	.....	200	.....
South Carolina.															
Charleston	.....	.....	3	.....	.....	.....	5	.....	.....	.....	.....	.....	.....	160	.....
Orangsburg	.....	.....	.....	.....	.....	.....	.....	.....	800	.....	.....	.....	.....	.....	.....
Tennessee:															
Dyersburg	.....	.....	.....	.....	.....	.....	2,000	2,000	.....	.....	.....	.....	.....	.....	.....
Texas:															
Paris	.....	.....	.....	.....	.....	.....	1,500	.....	.....	.....	.....	.....	.....	.....	.....
Utah:															
Salt Lake City	.....	7,324	399	53,498	.....	.....	.....	17,208	.....	37014	.....	.....	4,956	.....	.....
Virginia:															
Charlottesville	.....	.....	.....	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	20
Fredericksburg	.....	.....	300	300	.....	.....	1,016	4	.....	.....	.....	.....	.....	8	58
Staunton	.....	.....	.....	.....	.....	.....	.....	.5	.....	.....	.....	.....	.....	.....	.....
Suffolk	.....	.....	.....	.....	.....	.....	.....	.....	250	250	.....	.....	.....	.....	.....
Wisconsin:															
Manitowac	.....	.....	.....	.....	.....	.....	3,000	10	.....	.....	.....	.....	.....	40‡	500‡
Oshkosh	.....	.....	260	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Waukesha	.....	.....	.....	.....	.....	.....	.....	.....	1,721	1,721	.....	.....	.....	.....	.....
Wyoming:															
Cheyenne	.....	.....	.....	.....	.....	.....	7,200	7,200	2,820	2,820	.....	.....	.....	20	20

*Composed of concrete, cement pipe and vitrified pipe. †Brick and concrete, 30 to 60 inches. ‡Including catch-basins. §Brick and concrete.

Combined Sewers

Length (in feet or miles, and not including house or catch-basin connections) constructed in 1925 and in use at the end of year

City	Concrete (in place) Built in 1925	Concrete (in place) Total at end of yr.	Brick Built in 1925	Brick Total at end of yr	Segment Block Built in 1925	Segment Block Total at end of yr.	Vitrified Pipe Laid in 1925	Vitrified Pipe Total at end of yr.	Cement Pipe Laid in 1925	Cement Pipe Total at end of yr.	Other Kinds Kind	Other Kinds Laid in 1925	Other Kinds Total at end of yr.	Manholes Built in 1925	Manholes Total at end of yr.
California:															
Berkeley		10						2							
Illinois:															
E. St. Louis		5		0.32		0.77	10.3	107.80		7.62	Cast iron		.04	135	1,300
Oak Park						0.64	4.62	76.46	0.63	6.07				164	2,948
Indiana:															
Lafayette							4,137								
Iowa:															
Davenport		694													
Keokuk				8.87				14.30							
Kentucky:															
Ashland				10,067				68,286							193
Maine.															
Bangor				20.85			3,684	25.53		6.48	Ot. knds		0.78		354
Portland		.04		17		.5	1.36	66.40		15	Other kinds	.03	3.66	39	
Massachusetts:															
Fall River					231	1,744	12,307							110	
Haverhill		1.20		7.63			4,891	39.13						13	882
Lowell			120	133,720			11,528	525,528						51	
Lynn							57.40							14	
Michigan:															
Alma								95,040							252
Bay City							1.5	144.96						15	
Cheboygan								6							
Minnesota:															
New Ulm					3,720	5,440		4,720							
Red Wing		1		0.5		1	3	24			Other kinds		1.5		834
St. Cloud							10,950	42.12							
Montana:															
Billings		3,504													8
New Hampshire:															
Manchester		.26		8			12,865	98.50		5.6	Cast iron		.14	59	1,900
New Jersey:															
Newark	.20	1.38		63.19			.15	147.45	1.58	3.94	Oth knds		.33	220	9,987
New York.															
Auburn				39,820				490,143			Other kinds		20,030		
Elmira				63 360			10,113	391,175		21,120				55	
Man. Boro.															
N. Y. City	1,425		1,119				2,977		220					72	30,000
Troy							1,048								
Ohio:															
Bucyrus		0.5		2		1		24.75							
E. Cleveland				22,415		4,084	2,326	113,046			Stone and cast iron	150	150		
Fostoria							2,000								
Lancaster				.6			.42	20.1		2					
Middletown							1								
Newark							5,576	40.22						23	
New Boston		600		9,000											12
Wooster							550	115,906							190
Zanesville								21.68							455
Oregon:															
Oregon City							19,000	16							
Pennsylvania:															
Clearfield							.3	15							
Hazleton							364	67,097		7,456	Stone		13,587		
Mahanoy City							380							3	
Oil City							436								
Pottsville								11.5		60	Stone		8		30
Rhode Island:															
Pawtucket							2.55							92	
Providence			1.1184	78.8442			7.366	199.6246							
Virginia:															
Charlottesville								1							10
Washington:															
Anacortes								11.4							
Port Angeles								76,460	8,670	32,881				18	186
Spokane		4.5					2.68	157.5		1.5				68	2,682
Wisconsin.															
Marinette				1.625			.37	23						7	412

Inverted siphons—Newark, N. J., reported 3 inverted siphons; Elmira, N. Y., one; and New York City, 3.

Flushing Sewers

City	Method of Flushing	Automatic Flushtanks: No. in use	Automatic Flushtanks: Frequency of Flushing	No. of dir. ect connections with water mains	No. of flush. of entire system per yr.	Cost of flush. per mile: Labor	Water	Materials
Alabama:								
Florence	Fire hose	None	.....	.....	.....	.....	.....	.....
Huntsville	Flush tanks	60	6 to 12 hours	.....	.....	.....	.....	.....
Samson	Flush tanks	13	.....	None	.....	.....	.....	.....
Troy	Flush tanks	20	Twice a day	.....	.....	.....	.....	.....
Arizona:								
Bisbee	Fire hose	21	.....	None	.....	.....	.....	.....
Arkansas:								
Blytheville	Flush tanks	15	Twice a day	.....	.....	.....	.....	.....
Fayetteville	Flush tanks & fire hose	20	12 to 48 hours	.....	.....	.....	.....	.....
Paragould	Fire hose	....	.....	.....	.....	.....	.....	.....
California:								
San Rafael	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Watsonville	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Colorado:								
Colorado Springs	Fire hose	30	.....	25	2	3c	.....	$ 60.00
Sterling	Flush tanks	36	4 times per day	1	.....	.....	.....	.....
Connecticut:								
Ansonia	Fire hose, self-propelling nozzle & rods	....	.....	.....	.....	.....	.....	.....
Southington	Flush tanks	27	Once a day	.....	.....	.....	20c	.....
Florida.								
Fernandina	Flush tanks	17	4 times a day	.....	.....	.....	.....	.....
Tallahassee	Flush tanks	27	.....	.....	.....	.....	.....	.....
Georgia:								
Americus	Fire hose	50	Every 48 hours	.....	.....	.....	.....	.....
Brunswick	Flush tanks & hand flush'g	130	4 times a day	.....	4	$ 5.00	.....	$500.00a
La Grange	Flush tanks	135	Daily	.....	.....	.....	.....	.....
Macon	Hand flushing	50	Weekly	.....	50	.....	.....	.....
Marietta	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Idaho:								
Boise	Flush tanks	....	1 or 2 times a day	.....	.....	.....	.....	.....
Lewiston	Flush tanks	150	.....	2	2	.....	.....	.....
Illinois:								
Canton	Fire hose	....	.....	.....	.....	.....	.....	.....
Carbondale	Flush tanks	5	8 hours to 48 hours	.....	.....	.....	.....	.....
De Kalb	Fire hose	....	.....	.....	2	.....	.....	.....
East St. Louis	Fire hose	....	.....	.....	.....	.....	.....	.....
Kewanee	Flush tanks	38	Once a day	.....	.....	.....	$1,100.00	.....
Macomb	Fire hose	....	.....	4	4	.....	.....	.....
Oak Park	Fire hose	....	.....	.....	.....	.....	.....	.....
Venice	Flush tanks	26	.....	.....	.....	.....	.....	.....
Indiana:								
Lafayette	Fire hose	....	.....	.....	.....	.....	.....	.....
Lebanon	Flush tanks & fire hydrants	21	Twice a day	.....	.....	.....	.....	.....
Iowa:								
Charles City	Fire hose	39	Once a day	.....	2	.....	.....	.....
Cherokee	Fire hose	10	As set	.....	.....	.....	.....	.....
Davenport	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Fort Dodge	Flush tanks & fire hose	Over 100	½ to 2 hours	.....	4	.....	.....	.....
Keokuk	Sewer rods	20	.....	.....	.....	.....	.....	.....
Red Oak	Fire hose and rods	....	.....	.....	.....	.....	.....	.....
Kansas:								
Lawrence	Flush tanks	120	Once a day	.....	365	0.60b	3.50b	0.20b
Newton	Flush tanks	70	Once a day	.....	.....	.....	.....	.....
Wichita	Hose and tank wagon	....	.....	.....	12	.....	.....	.....
Kentucky.								
Louisville	Fire hose	....	.....	.....	.....	50.00	.....	.....
Winchester	Flush tanks	6	.....	.....	.....	.....	.....	.....
Maine:								
Bangor	Fire hose with spray	....	.....	.....	1	.....	.....	.....
Portland	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Massachusetts:								
Andover	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Brockton	Water pipe connections & fire hydrants	....	.....	Many	¼ to ½	.....	.....	.....
Brookline	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Fall River	Fire hose	....	.....	.....	.....	.....	.....	.....
Haverhill	Fire hose	....	.....	.....	.....	.....	.....	.....
Lowell	Fire hose	....	.....	.....	.....	.....	.....	.....
Lynn	Fire hose	....	.....	.....	.....	.....	.....	.....
Melrose	Fire hose	....	.....	.....	2	.....	.....	.....
New Bedford	Fire hose	....	.....	.....	.....	.....	.....	.....
North Adams	Fire hose	....	.....	.....	1	.....	.....	.....
Stoneham	Fire hydrants	....	.....	.....	1	.....	.....	.....
Waltham	Fire hydrants & water pipe connections	....	.....	212	1	563.53	50.00	.....
Watertown	Rope & brushes, rods	....	.....	75	once	8,000.00	.....	.....
Michigan:								
Alma	Fire hose	....	.....	1	2	.....	.....	.....
Bay City	Fire hose	....	.....	.....	3	.....	.....	.....
Cheboygan	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Muskegon Hgts.	Fire hose	5	4 times per month	.....	.....	.....	.....	.....
Owosso	.....	100	.....	.....	.....	.....	.....	.....
Pontiac	Fire hydrants	....	.....	.....	1-2	.....	.....	.....
Sturgis	Fire hose & flush tanks	16	About every 12 hours	.....	4	.....	.....	.....
Minnesota:								
Faribault	Fire hose	....	.....	.....	.....	.....	.....	.....
New Ulm	4" con. to street mains	....	.....	46	1 to 3	$40 to $45	$60 to $68	.....
Owatonna	Fire hydrants	....	.....	.....	2	5.00c	.....	.....
Red Wing	1,000 gal. flusher truck	....	.....	.....	2	$ 16.50	$ 4.80	$ 3.20
St. Cloud	Fire hose	....	.....	.....	.....	.....	.....	.....
Virginia	.....	....	.....	.....	2	.....	.....	.....
Mississippi:								
Hattiesburg	Hose & sewer machine	50	.....	.....	.....	.....	.....	.....
Missouri:								
Kirksville	Fire hose	62	About every 48 hours	.....	.....	.....	.....	.....
St. Charles	Flush tanks	144	About every 12 hours	1	.....	.....	.....	.....

City	Method of Flushing	Automatic Flushtanks: No. in use	Automatic Flushtanks: Frequency of Flushing	No. of direct connections with water mains	No. of flush. of entire system per yr.	Cost of flush. per mile: Labor	Water	Materials
Montana.								
Billings	Flush tanks & fire hose	99	2 or 3 times a day	....	1	.....	.....	.....
Nebraska:								
York	Flush tanks	25	Once a day	.....	.....	.....	.....	.....
New Hampshire:								
Manchester	Fire hose	....	.....	.....	.....	.....	.....	.....
New Jersey:								
Newark	Hand	....	.....	.....	.....	.....	.....	.....
Nutley	Fire hose	....	.....	10	.....	.....	.....	.....
So. Orange	Flush tanks	60	Once a day	.....	12	.....	.....	.....
Westfield	Fire hose	60	Once a day	.....	1	.....	.....	.....
New Mexico:								
Roswell	Flush tanks	150	Every 12 hours	.....	1	.....	.....	.....
New York:								
Auburn	Fire hose	....	.....	.....	.....	.....	.....	.....
Elmira	Fire hydrants & hose	....	.....	.....	.....	.....	.....	.....
Endicott	Fire hose	....	.....	.....	.....	.....	.....	.....
Geneva	Fire hose	100	Twice a day	.....	.....	.....	.....	.....
Gloversville	Fire hose from hydrants	....	.....	1	1	.....	.....	.....
Herkimer	Fire hose	45	30 min. average	.....	2	.....	.....	.....
N. Y. City, Man. Boro.	Fire hose	....	.....	.....	.....	.....	.....	.....
Rye	Flush tanks	24	Once a day	.....	2	.....	.....	.....
North Carolina:								
Greensboro	Flush tanks	120	Once a day	.....	2	$ 5.00	$ 1.00	25 cts.
Thomasville	Flush tanks	....	Monthly	150	12	.....	.....	.....
Wilmington	Flush tanks & fire hose	....	Twice a day	.....	.....	.....	.....	.....
Wilson	Flush tanks	....	.....	.....	.....	.....	.....	.....
North Dakota.								
Jamestown	Fire hose	....	.....	.....	.....	.....	.....	.....
Ohio:								
Cambridge	Flush tanks	....	.....					
East Cleveland	Storm water	...	.....	.....	.....	.....	.....	.....
Fostoria	Fire hose from hydrant	....	.....	.....	.....	.....	.....	.....
Lancaster	Fire hose	....	.....	.....	.....	.....	.....	.....
Middletown	Fire hose	1	Every hour	.....	.....	.....	.....	.....
Newark	Fire hose	....	.....	.....	.....	.....	.....	.....
New Boston	Fire hose and rods	6	.....	.....	.....	.....	.....	.....
Troy	Flush tanks	50	4 to 6 times per day	.....	.....	.....	.....	.....
Wooster	Fire hose	....	.....	.....	.....	.....	.....	.....
Zanesville	Flush tanks & Flush manholes	45	.....	85	.....	.....	.....	.....
Oklahoma:								
Guthrie	Flush tanks	30	2 to 3 hours	.....	.....	.....	.....	.....
Muskogee	Flush tanks & fire hose	70	.....	.....	.....	.....	.....	.....
Ponca City	Fire hose & city pressure	....	.....	.....	.....	.....	.....	.....
Tulsa	Fire hose with city water pressure	....	.....	.....	.....	.....	.....	.....
Oregon:								
Oregon City	Flush tanks	20	2 hour intervals	....	.....	.....	.....	.....
Pennsylvania:								
Allentown	Fire hose	....	.....	.....	2	$ 19.64	.....	.....
Clearfield	Fire hose & town hydrant pressure	....	.....	.....	.....	.....	.....	.....
Connellsville	Fire hose	....	.....	.....	.....	.....	.....	.....
Freeland	Fire hose	....	.....	40	.....	$35to$40	Free	hose, none
Hazleton	Storm water	....	.....	.....	.....	.....	.....	.....
Lansford	Flush tanks	5	Every 48 hours	.....	.....	.....	.....	.....
Lebanon	Flush tanks	200	Every 18 hours	.....	.....	.....	.....	.....
Mahanoy City	Fire hose	....	.....	.....	Once	$500.00	An.rent	Fire dpt
New Brighton	Flush tanks	27	Once a day	.....	.....	.....	$ 55.00	.....
Norristown	Flush tanks	All	Once a day	.....	.....	.....	.....	.....
Oil City	Fire hose	....	.....	.....	.....	.....	.....	.....
Sharon	Fire hose	....	.....	2	.....	.....	.....	.....
Steelton	Fire hose	....	.....	.....	12	.....	.....	.....
Throop	Fire hose	....	.....	.....	.....	.....	.....	.....
Tyrone	Fire hose	....	.....	.....	.....	.....	.....	.....
Uniontown	Fire hose	....	.....	.....	.....	.....	.....	.....
Warren	Fire hydrants	....	.....	.....	.....	.....	.....	.....
Wilkinsburg	.....	142	.....	.....	.....	.....	.....	.....
Rhode Island:								
Pawtucket	Flush tanks & flushing manholes	...	.....	.....	2	.....	.....	.....
Providence	Hydrant pressure	....	.....	.....	.....	$ 47.79	.....	.....
Westerly	Fire hydrants	....	.....	.....	4	.....	.....	.....
So. Carolina:								
Charleston	Flush tanks & fire hose	329	Once a day	.....	.....	.....	.....	.....
Greenville	Fire hydrants & hose	174	.....	.....	2	.....	.....	.....
Greenwood	Flush tanks	....	Twice per day	.....	.....	.....	.....	.....
Orangeburg	Flush tanks	78	Once a day	.....	365	.....	.....	.....
Texas.								
Weatherford	Fire hose	....	.....	.....	8	.....	$ 15.00	.....
Utah:								
Salt Lake City	Water turned on 2 & 3 times a month and allowed to flush sev. times	1,267	.....	1,180	.....	$ 18.05	.....	.....
Virginia:								
Charlottesville	Fire hose	....	.....	.....	.....	.....	.....	.....
Fredericksburg	Fire hose	....	.....	.....	Once	$4to$5	.....	.....
Suffolk	Flush tanks	29	.....	.....	.....	.....	.....	.....
Washington:								
Anacortes	.....	....	.....	1	2	.....	.....	.....
Port Angeles	Flush tanks	44	Once a day	.....	16,000	.....	$528 00	.....
Spokane	Flush tanks	500	Some daily; some once a week	.....	.....	.....	.....	.....
Walla Walla	Fire hose	50	30 min. to 4 hours	.....	.....	.....	.....	.....
Wisconsin:								
Manitowoc	Fire hose	....	.....	.....	2	$ 10.00	$ 15.00	Hose depre.
Marinette	Fire hose	....	.....	....	.....	.....	.....	.....
Oshkosh	Movable tanks & sewer bag	....	.....	.....	.....	.....	.....	.....
Wyoming:								
Cheyenne	Nozzle & fire hose	....	.....	...	2	$ 20.00	$ 8.50	.....
Waukesha	3" fire hose	....	.....	.....	6	.....	.....	.....

a—Per year. b—Per month. c—Total cost.

Cleaning Sewers

City	Method of Cleaning	Cost of Clean per Mi.—Labor	Materials	Appliances	Number of Stoppages per year	Method of Ventilating Sewers
Alabama:						
Birmingham	Dragging by hand.	.....	.....	.....	.....	Through house connections
Bessemer	Rods	.....	.....	.....	6	House con. & man'hl heads
Florence	.....	.....	.....	.....	.....	House con. & man'hl heads
Huntsville	Sewer Rods	.....	.....	.....	.....	Manhole heads
Troy	.....	.....	.....	.....	.....	House con. & man'hle heads
Arizona:						
Bisbee	.....	.....	.....	.....	.....	Manhole heads and special vent pipes
Arkansas:						
Blytheville	Self-propelling nozzle with water pressure	$25	$40	.....	.....	Traps and vents
Fayetteville	Rodding and water turbine root cutters	.....	.....	.....	41	Manhole covers
Paragould	Flushing only	.....	.....	.....	.....	.....
California:						
Berkeley	Rodding	.....	.....	.....	.....	.....
San Rafael	Flushing at manholes, rodding with root cutter	.....	.....	.....	.....	.....
Watsonville	.....	.....	.....	.....	2	Special vents
Colorado:						
Boulder	Sewer cutters and rods	.....	.....	.....	10 or 12	Manhole heads
Colorado Springs	Hand brushing and root cutting with rods	30a	.....	.....	32	Perforated covers and open stack system
Sterling	Water pressure	.....	.....	.....	3	Manhole heads
Connecticut:						
New Britain	Dragging with scoops	.....	.....	.....	5	Manhole heads
Southington	Flushing, sewer rods and root cutters	.....	.....	.....	.....	House connections & manhole heads
Florida.						
Fernandina	Sewer rods, fire hydrants and turbine	190b	.....	.....	42	House con. & manhole heads
Tallahassee	Rod and hose	65	400	.....	50	.....
Georgia:						
Americus	.....	.....	.....	.....	3	House con., manhole heads
Brunswick	Hand labor using rods and machine	50 to 100	250c	$250c	4	and yard vents House vents & man'hle cov's
Fitzgerald	Hand labor	.....	.....	.....	.....	.....
La Grange	Fire hose	11	.....	.....	6	House connections
Macon	Rods	.....	.....	.....	.....	House connections
Idaho:						
Boise	Chain dragged through in Spring	.....	.....	.....	.....	Manholes, house con. & vents
Lewiston	Nozzle and hose	60	.....	.....	10	.....
Illinois:						
Canton	Nozzle and hose	.....	.....	.....	.....	House Con. & manhole heads
East St. Louis	Drag buckets	10	.....	.....	2	Manhole heads
Kewanee	Rods and hose	2	.....	.....	2	House connections
Macomb	.....	.....	.....	.....	Few	Manhole heads
Oak Park	Sewer rods and buckets	.....	.....	.....	.....	Manhole heads
Wilmette	.....	.....	.....	.....	.....	Manholes
Indiana:						
Lafayette	Sewer sticks and flushing with fire hose	.....	.....	.....	.....	.....
Lebanon	Rods & water pressure	.....	.....	.....	6	House con. & manhole heads
Peru	.....	.....	.....	.....	.....	Manhole heads
Iowa:						
Charles City	Small drags, self-propelling nozzle and 1,000' fire hose	100 a month d		.....	6	Manhole heads
Cherokee	Rods and water	.....	.....	.....	.....	.....
Davenport	Rods and flushing	.....	.....	.....	.....	.....
Fort Dodge	Turbine machine	.....	.....	.....	6	Perforated manhole and
Keokuk	Sewer rods, excavation where required	.....	.....	.....	.....	lamphole heads Manholes, inspection heads, street inlets (no traps)
Oelwein	Rodding	.....	.....	.....	.....	.....
Red Oak	Rods with shovels & tools attached & hose	.....	.....	.....	2	House con. & manhole heads
Kansas:						
Lawrence	Sewer rods	.....	.....	.....	20-25	Manhole heads for laterals and mains
Newton	Sewer rods and flushing	.....	.....	.....	.....	House vents & manhole vents
Wichita	Hose flushing—crawler nozzle—drag buckets	.....	.....	.....	.....	House connections
Kentucky.						
Ashland	.....	.....	.....	.....	.....	Manholes
Louisville	Rods and flushing	200	47.22	.....	4	Vent pipe through house con.
Maine:						
Bangor	.....	.....	.....	.....	.....	Manhole heads
Cumberland Mills	.....	.....	.....	.....	.....	Through house connections
Portland	Sewer cleaning machine	.....	.....	.....	5	Manhole heads
Maryland:						
Baltimore	.....	.....	.....	.....	383	
		.....	.....	.....	mn. line	Individual vents on each
		.....	.....	.....	761	line. Manhole frames per-
		.....	.....	.....	hse.con.	forated
Massachusetts:						
Andover	.....	.....	.....	.....	2	House connections
Brockton	Rods, buckets, etc.	.....	.....	.....	.....	Holes in manhole covers
Brookline	.....	.....	.....	.....	.....	Through manhole covers
Fall River	Rods & "snake" for small, men for large	.....	.....	.....	.....	House con. & manhole heads
Haverhill	Rods and steel buckets					.....
Lowell	Turbine cleaning machines, orange peel buckets, air c'mprs'r	.....	.....	.....	.....	.....
Lynn	.....	.....	.....	.....	.....	Manholes and ventilators at end of sewers
Melrose	Derrick, rods, rope & follower	.....	.....	.....	50	House connections
New Bedford	Turbine	.....	.....	.....	.....	House con. & manhole heads

City	Method of Cleaning	Cost of Clean per Mi. — Labor	Materials	Appliances	Number of Stoppages per year	Method of Ventilating Sewers
Massachusetts (Continued)						
North Adams	Sewer rods	.....	.....	.....	.....	.....
Stoneham	.....	.....	.....	.....	4	.....
Waltham	Rope, chains, followers, and scrapers	.....	.....	.....	15	Through con. to house roof
Watertown	Rods and brushes	.....	.....	.....	100	Manhole heads
Wellesley	.....	.....	.....	.....	.....	House con. & manhole heads
Michigan:						
Alma	Sewer rods and cable	.....	.....	.....	.....	House con. & manhole heads
Cheboygan	.....	.....	.....	.....	3	Pipes
Hastings	City water	.....	.....	.....	.....	.....
Muskegon Heights	.....	.....	.....	.....	2	House vents
Owosso	Turbine sewercleaning machine	.....	.....	.....	10	House connections
Pontiac	Machine	.....	.....	.....	120	Outside vents
Sturgis	Rodding with cable and bucket	.....	.....	.....	4	.....
Minnesota:						
Faribault	Sewer rods	.....	.....	.....	.....	Manhole heads
New Ulm	Flushing	.....	.....	.....	2	.....
Owatonna	Sewer cleaning machine	.....	.....	.....	10	House con., manhole heads, special vent pipes, etc.
Red Wing	Rods	.....	.....	.....	2	Catch basins, vents in manhole covers
St. Cloud	Scoops and turbine sewer cleaning machine	.....	.....	.....	2	.....
Virginia	Flushing	.....	.....	.....	.....	.....
Mississippi:						
Faribault	.....					
Hattiesburg	.....	.....	.....	.....	.....	Vent pipes and manholes
Missouri.						
Kirksville	Fire hose and sewer rods	.....	.....	.....	50	.....
Montana:						
Billings	Dragging basket in sewers 12' to 18' diameter. Smaller sizes flushed with hose	65	65	.....	25	House connections
Nebraska:						
York	Revolving water driven cleaning machine	.....	.....	.....	.....	House connections
New Hampshire:						
Manchester	Rodding and flushing	.....	.....	.....	.....	Catch basins, manhole heads
New Jersey:						
Newark	Hand, rods and line	.....	.....	.....	.....	Manhole heads
Nutley	Scraping, brushing and flushing	.....	.....	.....	3	House connections
So. Orange	.....	.....	.....	.....	1	.....
Westfield	Sewer rods and wire brushes	.....	.....	.....	.....	House connections
New York:						
Auburn	Flushing and turbine machine	.....	.....	.....	660	Catch basins & manh'le h'ds
Elmira	Two winches, cable & scoops, with jointed rods	.....	.....	.....	12	House con. & manhole heads
Endicott	Sewer rods & water under pres're	.....	.....	.....	4	Manholes and catch basins
Geneva	Revolv. nozzle on hose, & rods	.....	.....	.....	10	Manhole covers
Gloversville	Sewer rods and flushing	.....	.....	.....	.....	Manhole heads
Herkimer	.....	.....	.....	.....	.....	House connections
Manhattan Boro New York City	Hose and rods in pipes; shovels and buckets in brick sewer	.....	.....	.....	.....	Manhole heads
Rye	Flushing and wire brush	.....	.....	.....	.....	No house traps—free circulation thru buildings
North Carolina:						
Greensboro	Rods, rope, chain and water	.....	.....	.....	100	Manhole covers
Thomasville	Rods	.....	.....	.....	3	Manhole heads
Wilmington	Sewer machine, fire hose, rods and wire cables	.....	.....	.....	91 mn.ln 238 hs cn	House connections
Wilson	Rods and buckets	.....	.....	.....	.....	Manhole heads
North Dakota.						
Jamestown	Jointed rods & torpedo nozzle	.....	.....	.....	2	House vents and perforated manhole covers
Ohio:						
Bucyrus	Sewer cleaning machine	52	.....	.....	.....	Manhole covers
Columbus	.....	.....	.....	.....	.....	Manhole heads
East Cleveland	Rods, flushing and turbine	15.20	9.50	.....	94	Manhole covers
Fostoria	.....	.....	.....	.....	.....	Manhole heads
Jackson	Turbine cleaner	.....	.....	.....	.....	Manhole heads
Lancaster	.....	.....	.....	.....	.....	Manhole heads
Middletown	Fire hose and self-propelling noz.	.....	.....	.....	.....	House connections, manh'le heads, spec. vent pipes, etc.
Newark	Sewer cleaning machine	.....	.....	.....	.....	House con. & perforated manhole covers
New Boston	Rods and flushing with fire hose	.....	.....	.....	.....	Manholes
Wooster	.....	.....	.....	.....	.....	Manhole heads
Zanesville	Fire house and cleaning machine	.....	.....	.....	.....	Manhole heads
Oklahoma:						
Guthrie	Fire hose	.....	.....	.....	Few	Standard trap and 4" soil pipe
Ponca City	Rods and water	.....	.....	.....	.....	House con. & manholes
Tulsa	Barb-wire swab and rods	36	.....	.....	5	House connections
Oregon:						
Oregon City	Rods, tape and nozzle	.....	.....	.....	.....	Manhole heads
Pennsylvania:						
Allentown	.....	.....	.....	.....	.....	House con. & manhole covers
Clearfield	Shovel dirt from large manholes	.....	.....	.....	3	House con. & manhole heads
Connellsville	.....	.....	.....	.....	.....	Manhole heads
Freeland	.....	.....	.....	.....	.....	Manh'le h'ds, house vents, etc.
Hazleton	Rods	.....	.....	.....	2	.....
Lebanon	.....	.....	.....	.....	.....	Manholes
Mahanoy City	Fire hose	500	Pumper	.....	3	.....
New Brighton	.....	.....	.....	.....	.....	Vent pipes
Norristown	.....	.....	.....	.....	7	Trap and vent at curb and then to roof
Oil City	Hand, hose, jointed rods, etc.	.....	.....	.....	.....	House connections
Pottsville	Fire hose	.....	.....	.....	10	Inlets
Sharon	Sewer machine, cable and buckets	.....	.....	.....	.....	Vents
Steelton	Rev. sewer clean. at. end of hose	.....	.....	.....	12	Manholes
Throop	Flushing	.....	.....	.....	.....	Manhole heads
Tyrone	Fire hose	.....	.....	.....	3	House con. & manhole heads
Uniontown	Torpedo nozzle and rods	.....	.....	.....	.....	.....
Warren	Fire hose and nozzle	.....	.....	.....	2	House con. & manholes
Wilkinsburg	Fire hose	.....	.....	.....	5	House con. & manhole heads

City	Method of Cleaning	Cost of Clean per Mi. Labor	Mater.	Apl'nc's	Number of Stoppages per year	Method of Ventilating Sewers
Rhode Island:						
Pawtucket	Stewart machine	.....	.....	.....	.....	.....
Providence	Hand method	122.59	.....	.....	1	Manhole heads
Westerly	Flushing	.....	.....	.....	.....	Manhole heads & hse. con.
South Carolina:						
Charleston	For pipe, hose with self-propelling nozzle; for brick & conc. drains, hand line & windlass	.....	.....	.....	.....	House connections
Greenville	Flushing and rods	.....	.....	.....	.....	Vents in manhole heads
Greenwood	.....	.....	.....	.....	12	Manholes
Orangeburg	Flushing with fire hose using fire pumps	.....	.....	.....	2	House con. & manhole heads
Tennessee.						
Dyersburg	.....	.....	.....	.....	30	House connections
Texas:						
Brownwood	.....	.....	.....	.....	.....	House vents
Paris	Fire hose	.....	.....	.....	36	.....
Weatherford	Rods	.....	.....	.....	25	Cast iron pipe
Utah:						
Salt Lake City	Flush. & automatic mach. drag	14.95	.....	.....	20	Vent pipes thru house roof & perf. manhole covers
Virginia:						
Charlottesville	Fire hose and sewer rods	.....	.....	.....	20	House vents (Intake air at manholes
Fredericksburg	Sewer rods or mandrell	7.00	4.00	.....	4	House con. & manhole heads
Suffolk	.....	9.00	.....	.....	4	House connections
Washington:						
Anacortes	Fire hose	.....	.....	.....	.....	.....
Spokane	Dragging with a bucket	.....	.....	.....	.....	Manhole covers
Port Angeles	Rods	4.35	.....	.....	2	All houses have 4" vent; also manholes
Walla Walla	Rods and fire hose	.....	.....	.....	.....	.....
Wisconsin:						
Manitowoc	Turbine sewer machine	.....	.....	.....	5	Manhole heads
Marionette	Rods, bucket and windlass	.....	.....	.....	5	House con. & manholes
Oshkosh	Sewer bag by back flushing, or sewer cleaning machine	.....	.....	.....	.....	.....
Wyoming:						
Cheyenne	Rods, cable and buckets	125	.....	.....	8	.....
Waukesha	Turbine sewer machine	.....	.....	.....	4	.....

a—Includes labor and materials. b—Total cost per mile of cleaning and repairs. c—Per year. d—Total cost of keeping man on job. e—Main sewers.

Preventing Asphalt Pavement Displacement

With the increase in weight and intensity of traffic being carried by pavements, some of the asphalt pavements which were not designed for such traffic have, during the past few years, shown a tendency to form waves by displacement of the asphalt. Engineers have been studying this problem and have made some progress towards devising methods of increasing the resistance of hot mix pavements to displacement. In this connection Prevost Hubbard, chemical engineer of the Asphalt Association, calls attention to the danger that certain trends of practice for securing this result will, if carried to extremes, result in the production of pavements which are more apt to crack in cold weather due to contraction.

He says:—"It has been definitely established that increasing the percentage of filler, decreasing the percentage of asphalt and hardening the asphalt will produce a more stable pavement than has frequently been laid in past years, but we have not as yet determined just how far we should proceed along these individual lines.

"During the past two years the Asphalt Association has developed a test for measuring stability of fine aggregate asphalt paving mixtures, but the evaluation of this test in terms of service results has not as yet been completed. The test shows the relative stabilizing effect of all of the factors above mentioned and indicates that increase in percentage of filler is perhaps the most effective. At the present time data are being assembled in connection with the stability of pavements of known history subject to various climatic and traffic conditions and it is hoped that in the near future the influence of these factors will be properly evaluated both with relation to stability at high temperatures and resistance to cracking at low temperature.

"Until this work is further advanced the writer feels that it is particularly dangerous to proceed to extremes in hardening the asphalt cement or in greatly reducing its percentage in the paving mixture, as it is believed that the longest serviceable life and greatest resistance to cracking will be obtained from mixtures carrying the largest percentage of a moderately soft asphalt which will produce the degree of stability required by the traffic and climate which it will have to meet. It is therefore urged that engineers proceed cautiously in modification of their customary practice, particularly along these lines."

Taste in Chlorinated Water

An English Publication, "The Medical Officer," in a recent issue published two articles dealing with the taste of chlorinated water, one by Alexander Houston, and the other by B. A. Adams. Mr. Houston states that in the laboratory a chlorinous taste can be removed by rechlorination, but under practical working conditions it is not certain that this method can be applied successfully on a large scale. Permanganate does not remove a chlorinous taste, but renders it more pronounced. Moreover, permanganate has itself an objectionable taste and unless used with great discretion may actually augment taste troubles.

Iodoform taste arises from a number of perplexing factors. It is associated with minor doses of chlorine and seems to be produced by

the action of chlorine on substances about which little is known. The iodoform taste may be produced by adding traces of phenol bodies or by filtering through a Berkfeld filter. Waters containing little oxidizible substance, notably well waters, are particularly susceptible to these tastes and it is therefore believed that the taste can not be due wholly to the action of chlorine on organic matter. Such tastes may be absent at the purification plant or in the larger mains but appear at the outer ends of the distribution system.

Iodoform tastes can not be removed by dechlorination. Permanganate usually prevents their formation or removes them, but if the permanganate has been absorbed and the water still contains free chlorine, this may act on substances afterward reaching the water and again produce an iodoform taste. Chlorine in excess may also prevent or remove an iodoform taste, in which case dechlorination leaves no aftertaste.

Mr. Houston refers to a third class of taste which he calls indeterminate, stating that they are termed by others variously as "earthy," "mouldy," "damp straw," etc. These, he said, are very similar to tastes found in untreated waters. They are not so common or objectionable as iodoform tastes and some of them can be removed or obviated, but others seem to resist this.

Mr. Adams stated that during a series of observations on chlorinated water stored in open tanks near an industrial center, it was noticed that the iodoform taste appeared immediately following light rains or heavy fogs with the wind blowing from the neighborhood of a gas plant and it was concluded that the taste was caused by some constituent in the atmosphere and that this constituent was probably of a phenoloid character derived from gas works or imperfectly burned coal. It was also believed that the reaction does not occur if the water contains a trace of free ammonia nor if the chlorinated water is not exposed to the air or if it contains an unusual amount of organic matter. It was therefore concluded that a chlorinated water should not be exposed to the air in the proximity of towns or gas works, nor afterwards mixed with water that has been so exposed. Mr. Adams said that sodium hypochlorite applied in conjunction with ammonia is the most effective corrective treatment for eliminating an iodoform taste.

Earth Roads Investigation

A year ago we announced the appointment of Prof. S. S. Steinberg as chairman of the Committee on Development of Earth Roads of the Highway Research Board, and in our December issue published the first report of that committee as presented to the annual meeting of that board on December 4th. In the same issue we expressed editorially our belief in the importance of the work to be done by this committee.

Unfortunately Prof. Steinberg has found his time so occupied with his duties as assistant director of the Research Board that he is unable to give to the earth roads research the attention that it should receive, and Charles M. Upham, director of the board, announces the appointment of C. N. Conner as chairman of that committee. Mr. Conner will give full time to this work, continuing the investigation of intermediate type road treatments and experiments from the preliminary stages through which it has thus far been conducted.

Mr. Conner has had a broad engineering experience. After graduating from Tufts College in 1908 he was for two years on construction with the New York Central R. R., following which he was for three years assistant engineer with the Bureau of Public Works, Philippine Islands. Later he was assistant engineer with the War Department and then with the Navy Department.

He then became assistant engineer with the Delaware Highway Department during much of its heavy construction work, following which he was for three years state construction engineer with the North Carolina Highway Commission and for one year state construction engineer and head of the testing and research laboratory of that organizations. During the past year he has been chief engineer of the Mexican National Highway Commission.

Welded Pipe Used by California Contractor

Substitution of welded pipe lines for the former system of screw pipe is being tried on concrete paving projects in California. A description of the plan used on the Jahn & Bressi contract, north of San Juan Capistrano, is furnished by C. N. Ainely, resident engineer.

Jahn & Bressi contracted with a pipe company for the complete handling of the pipe during the period of construction. The pipe used, second-hand boiler tubing, is strung out over portions of the job where it is to be needed and is then welded by means of an acetylene torch. The cost of installing, which includes welding joints and pipe stubs for hydrants at 100-foot intervals, was reported to have been 3½c per foor for 3″ pipe and 5c per foot for 4″ pipe.

With the joints laid end to end as unloaded from the truck, one man can average 35 welded joints per day. The time of welding in a stub for hydrants is about 10 minutes.

The use of welded pipe has a number of advantages. The line can be shifted without danger of breaking, if ordinary care is used; a leak or break is easily repaired, and the line is readily disconnected with the torch for moving.

The boiler tubing with the welded joints used on this job will stand about 500 pounds pressure. It is asserted that friction head was lessened by the use of this kind of pipe. Welded pipe has been used on two jobs with success, which, apparently, establishes the fact it is cheaper than former methods.

Recent Legal Decisions

LUMBER FURNISHED ROAD CONSTRUCTION CONTRACTOR WITHIN SURETY BOND

A contract for the construction of a state highway in North Carolina was given to two construction firms, and the work was done by one of the firms under the supervision and control of the other. The firm doing the work became bankrupt and abandoned the work before completion. The North Carolina Supreme Court holds, Alderholt v. Condon, 189 N. C. 748, 128 S. E. 337, that the firm doing the work was the agent or employee of the other, and, along with the surety on the construction bond by the general partnership, was liable to laborers and material men, whose claims were sufficiently covered by the contract and the surety bond. Lumber furnished the contractor to put up a rock crusher and for boxes, dump carts and other things were held to be "materials" within the meaning of the bond, though not put directly into the highway.

RECOVERY BY CITY OF 10 PER CENT OF COST OF REPAIRING STREET RAILWAY TRACKS AS OVERHEAD EXPENSES

In a city's action against a street railway company for costs of repairing part of a street occupied by defendants' tracks, the Virginia Supreme Court of Appeals holds, Lynchburg Traction & Light Co. v. City of Lynchburg, 128 S. E. 606, that the city might recover 10 per cent. on the actual costs of labor and material furnished for repair, allowed under the contract between the parties, this not being a mere penalty. The contract for other repairs made by the city for the company called for costs plus 10 per cent. Such contracts are not at all unusual, and it appeared from the evidence that 10 per cent. was a reasonable charge for overhead expenses.

INCORPORATED TOWN MAY BE ANNEXED UNDER VIRGINIA STATUTE

In view of the express terms of Virginia Code 1919, sections 2958, 2962, the Virginia Supreme Court of Appeals holds, Nexsen v. Board of Superintendents of Elizabeth City County, 128 S. E. 570, that power to a city or town to annex "outlying territory adjacent" thereto, given by sections 2956, 2957, is not limited to outlying unincorporated territory, but may include an incorporated town.

MUNICIPALITY HELD NOT LIABLE FOR NEGLIGENT CONSTRUCTION AND OPERATION OF INCINERATOR

In an action against a municipality for injuries to plaintiff's eyesight by the alleged negligent construction and operation of an incinerator by defendant city, the North Carolina Supreme Court held, 189 N. C. 469, 127 S. E. 543, that, applying the principle of non-liability of a municipal corporation for injury caused by negligence in the exercise of its governmental functions, the city was not liable, the incinerator having been built in the discharge of a governmental function. The power to maintain public works, buildings and improvements, to remove garbage and to provide for the health, comfort and welfare of the people, is conferred by N. Car. Comp. St. section 2787, subds. 5, 6 and section 2799. It was in pursuance of this legislation that the furnace was constructed, and the acts complained of were in the performance of duties authorized by law solely for the public benefit, governmental in character, and not merely private and corporate.

WEST VIRGINIA COUNTY COURT CANNOT BARTER ONE PUBLIC ROAD TO ESTABLISH ANOTHER

The West Virginia Supreme Court of Appeals holds, Marion County Court v. Hall, 128 S. E. 284, that a county court is without authority to sell or barter the right of way of a public road, the continuance of which is required to serve the public as a necessary outlet, for the purpose of establishing another. A county road, it is held, once established, continues as such until vacated or discontinued in the manner prescribed by law.

ELECTRIC POWER "LABOR" WITHIN ROAD CONTRACTOR'S BOND

The North Carolina Supreme Court holds, Town of Cornelius v. Lampton, 189 N. C. 714, 128 S. E. 334, that electric power furnished by a town for a rock crusher and cable cars is equivalent to labor and within a highway contractor's bond to pay therefor, the power being an integral part of the work and not merely "instrumentalities" or "tools," although the rock crusher and cable cars were instrumentalities.

ROAD CONTRACTOR'S ASSIGNMENT OF FUNDS DUE SUBJECT TO COMMISSION'S RIGHT TO APPLY FUNDS TO CLAIMS AGAINST CONTRACTOR

The South Carolina Supreme Court holds, Yancey v. Stark, 129 S. E. 81, that where a road contract authorized the highway-commission to retain a sufficient amount to pay claims "for any work, material or labor done for, furnished or supplied" to the contractor upon the work contracted for by him, an assignment by the contractor to a third party of part of the amount due to him was made subject to the commission's contract rights to apply the funds accruing on the contract to payment of claims of the character described, the assignment being subject to all the equities existing between the original parties, not only at the time of the assignment, but up to the time of notice to the debtor.

INJURIES BY BURNING RUBBISH SET ON FIRE BY STREET SWEEPER

The Georgia Court of Appeals holds, Mayor, etc. of Savannah v. Waters, 125 S. E. 772, that the duty of keeping the streets of a municipality free from matter which, if allowed to remain, would affect the health of the public, is a governmental function, the exercise of which would

exempt the municipality from liability to a suit for damages for the negligence of servants of the city while actually engaged in and about such work; and thus a petition which relates to the work of hauling, in a municipal cart, of "the sweepings of the street" describes a governmental function, nothwithstanding the petition describes the sweepings as "dirt and trash." In an action for injuries caused by a fire set in a street by a street sweeper to a quantity of leaves, sticks and other trash which he had swept up, it was held that under the allegations of the petition the negligence complained of related to the lack of care in the actual performance by the city of the destruction by it of the accumulated trash, and consequently its general demurrer to the petition should have been sustained.

AWARD OF PUBLIC WORKS CONTRACTS IN ABSENCE OF STATUORY PROVISION

The New York Appellate Division holds, A. W. Dovel Co. v. Village of Lynbrook, 213 App. Div. 570, 210 N. Y. Supp. 183, that the New York General Municipal Law, section 88, simply requires separate and independent bidding for the different classes of public work, and the awarding of the contract to a responsible and reliable bidder. Nothing in that statute requires advertisement for bids and the awarding of the contract to the lowest responsible bidder, as is required by numerous other municipal charters. In the absence of a mandatory statute requiring the letting of a contract by competitive bidding, it is not required, and a board of trustees was held authorized to award a public works contract to one known to them to be competent and capable to do the work, even though he was not the lowest bidder. In other words, in the absence of some statutory requirement or evidence of bad faith, it was entitled to use its judgment in awarding the contract to the same extent that an individual would be.

CONSTRUCTION OF ROAD CONTRACT AS TO COMPENSATION PER CUBIC YARD

The Arizona Supreme Court holds, State v. Kisselburg, 233 Pac. 580, that where a road contract called for the payment of 90 per cent. of the value of the completed work in installments as the work progressed, the contractor had the right to sue for installments due before the completion of the entire contract. The court holds the better rule to be, although the decisions on the point are not in harmony, that, although parties to such a contract may stipulate that the decision of some designated person, even though an agent of one of them, shall be binding as to disputed questions of fact, such as quantity and quality of the work done, no such stipulation can be made binding parties to accept a decision of law from the umpire, such as the legal meaning of a contract, or the terms thereof. The dispute in this case was whether the unit measure of the surfacing material was loose cubic yardage, as claimed by the contractor, or compacted yardage, in place on the road. Construing the specifications, the bid and the contract, the court held that the bid was made on the basis of loose cubic yardage, f.o.b. car, plus overhaul, and the contract provided the unit price is set forth in the bid; and therefore the contract called for loose cubic yardage.

UNAUTHORIZED USE OF LAND AS ROAD DOES NOT ESTABLISH HIGHWAY

The Nebraska Supreme Court holds, Mosier v. Herman, 202 N. W. 875, that a board of county commissioners may, without petition or notice, make a preliminary order establishing a section line road, by declaring that it shall be opened; but before it can be actually opened there must be proceedings upon proper notice to ascertain damages. The fact that the county goes upon an owner's land and uses it for a road, by the owner's passive permission or without his knowledge, is not sufficient, even though the county commissioners have without jurisdiction declared the road established by consent, to secure said land for said road, unless the user has been for the prescriptive period.

COUNTERCLAIM IN ACTION BY STATE NOT ALLOWED FOR IN NEW YORK STATUTES

The New York Appellate Division holds, People v. Greylock Const. Co., 209 N. Y. Supp. 735, that a counterclaim on contract cannot be interposed in a contract action brought by the state against an individual, in view of section 659 of the New York Civil Practice Act. Sections 1206 and 1207 are procedural only and do not grant the substantive right, nor has the state otherwise granted the right.

REQUIREMENTS CONTRACT FOR ALL REPAIR WORK NEEDED DURING YEAR HELD VALID

The awarding of a requirements contract for doing such work as might be required on the city streets during the year on a unit basis was held to be a legal contract, in Grace v. Scott, 125 Misc. 660, 211 N. Y. S. 68, any attempt to have determined at the time of awarding the contract the exact amount of work to be done being impossible, and where to have attempted to estimate a definite quantity of work and when that amount of work was done to have readvertised for further work when necessary, would have increased the cost of the repair work for the season.

EFFECT OF STATEMENT IN SPECIFICATIONS ON CONTRACTOR'S AGREEMENT TO EXCAVATE TO SOLID LEDGE

In an action for breach of contract in failing to excavate to a solid ledge in building a bridge pier, the Circuit Court of Appeals, Second Circuit, held, United Const. Co. v. Town of Haverhill, N. H., 9 F (2d) 538, that if the plans and specifications for the bridge were in fact a representation as to the character of the foundation at the depth specified therein, and that piers of the prescribed dimensions would reach to solid ledge, the contractor's general engagement to be responsible for foundations would not excuse the towns for misrepresentation, but on the contrary, the misrepresentation itself would excuse the contractor from the performance of its promise to excavate to solid ledge.